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A. J. Wegmann

This issue of the Proceedings is respectfully dedicated to the memory of Mr. A. J. Wegmann, longtime member of the Executive Committee of the Gulf and Caribbean Fisheries Institute. "Al" was an enthusiastic supporter of the Institute and his encouragement and energetic help were of great assistance in forming the policy of the organization. He will be missed also as a warm friend of all who knew him.

His generosity was well known to those fortunate enough to be his friends, and it was no surprise to them that one of his bequests was a grant to The Marine Laboratory of the University of Miami, to assist in marine fisheries work. A plaque on the new Marine Laboratory building, to be opened in 1957 on Virginia Key, Miami, will bear witness to Mr. Wegmann's lasting interest in fisheries research.

Acknowledgments

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MONDAY—NOVEMBER 26

Chairman—F. G. WALTON SMITH, *Chairman, Gulf and Caribbean Fisheries Institute; Director, The Marine Laboratory, University of Miami, Coral Gables, Florida*

OPENING ADDRESS

The Federal Government's Role in the Development of New Fishery Resources

ARNIE J. SUOMELA

Commissioner
Fish and Wildlife Service
Washington, D. C.

THE FEDERAL GOVERNMENT'S ROLE in the development of new fishery resources is a partnership role—a partnership with the fishing industry of the United States. It is a partnership to convert the great raw resources of the sea to consumer products. Unlike business partnerships that are set up under rigid rules and regulations, however, this is one that is flexible enough to permit the Fish and Wildlife Service, representing the Government in this instance, to help the industry when real needs exist and to withdraw when the basic problems have been resolved.

In many parts of the country the fishery industry consists of hundreds of individual fishermen and small processing plants scattered sparsely along miles of coastline. Their facilities for gaining basic knowledge which will lead to new and advanced methods of fishing and processing the catch nearly always are limited. Sometimes group efforts can achieve the desired results, but organization and financing, more often than not, turn up as major stumbling blocks. In other cases, however, where large and adequately financed companies exist, more research of all kinds is pursued by the industry.

Thus, the degree of governmental function in the partnership must reasonably be related to the varying conditions that are found in each fishery or particular location. This is as it should be, because it is almost axiomatic that whatever Federal benefits are available should be directed towards those problems that are most difficult for the industry to solve by itself. This, we in the Service try to do. However, without this flexibility for governmental decisions in the partnership, it could well become an unbalanced arrangement in which Government research and services would duplicate or overlap those of industry. Any duplication of this kind should be guarded against, since we universally accept the principle in our country that industry, where it can, should take the primary steps in behalf of its own advancement and development.

How then does the Government find its role in the charting of new fishing grounds, developing better means of harvesting the resource, and creating channels for its wise utilization? The foremost reason, probably, is centered in the magnitude of the job and the financial aspects of it. For example, exploration and development is an exhausting, time-consuming and extremely expensive

undertaking, regardless of whether it is connected with the location of new oil fields, mineral deposits or fishing grounds. Probably most of our citizens are more fully aware of the huge, offshore oil exploratory installations because they have been given much general publicity. On the other hand, probably fewer realize that marine exploration for new fisheries, with its costs of modern sea-going vessels, electronics equipment and heavy operating expenses, would rank well up in financial requirements with any other kind of exploration if pursued to the same extent. Yet, it is doubtful that the ultimate value of a newly located fishery resource is always comparable, dollarwise, to that of a new oil field or mineral deposit.

Beyond this there are certain incentives and advantages in most fields of exploration, not found in fisheries exploration, for investing heavily with reasonable expectation of future return on the investment. Again, considering oil or mineral exploration for a moment, it is improbable that a company would rush into development of a prospective deposit without first holding some control of the rights to the property upon which their investigations were taken place. There are appropriate means of obtaining leases or outright ownership before capital is ventured for such exploration.

Now, in the fisheries, who owns the fish on the high seas beyond international boundaries? No man may say that under present international law he has sole right to a fishery resource even though he may be engaged in reducing it to possession by fishing. Unless there are special treaty provisions, all fishermen, regardless of nationality, have equal rights to the resource. Where there is no provision for sole rights there is meager encouragement for an individual to finance, in any substantial manner, systematic exploration of the high seas.

If we reduce what has just been said to its simplest terms, it merely means that when the most enterprising and venturesome fisherman spends his money to find new grounds, the others, and if you please, his competitors, cash in on his investment. It is doubtful that there are many adroit businessmen who would call this a sound proposition.

It is here that under our partnership policy the Service's exploratory fishing and gear research programs can be most helpful, since it is obvious that when the Government enters this field the costs are spread among the many and the results become available on an equitable basis.

In carrying out these programs the Government, usually, is in a better position than individuals to relate the various biotic factors involved in the basic appraisal of the extent of a new resource. Also, in the gear research necessary to accomplish most efficient fisheries production, the Government, because of the nature of its work, has at its command adequate facilities for statistical evaluation of gear improvements. Only by the full interpretation of the interrelationship of all of these factors can the maximum advantages accrue to the fishermen. Omission of some factors and only partial interpretation of the balance of them not only diminish the practical value to the fishermen, but may even result in the more serious danger of pointing a newly developed fishery operation in a wholly wrong direction.

At this point the Service has another responsibility since it is a conservation agency, dedicated from its beginning in 1871 to the wise use of renewable resources. However, we see no conflict between the development of new resources on a sustained yield basis and this concept of conservation. Indeed, the location and development of new and potentially valuable fisheries tend to

remove pressure from stocks already fished near to the limit of their maximum productivity.

So, to what extent and to what degree does the Government participate in this field? It perhaps is easiest to look at some particular situations, like the discovery of yellowfin tuna in the Gulf of Mexico and the finding of deep-water red shrimp, to illustrate the answer. Substantial sub-surface stocks of yellowfin tuna were first discovered in the Gulf of Mexico by the Service's exploratory fishing vessel *Oregon* in 1954. Prior to that time several years were occupied by our staff in gathering background data and in making observations on the occurrence of this species in the Gulf. Longline gear, of a style adapted from the pattern traditionally used by the Japanese, was constructed and tested for its effectiveness in these waters and emphasis is still being placed on adjustments to make it more suitable for Gulf vessels and fishermen.

In the course of the exploratory fishing operations several hundred thousand pounds of yellowfin tuna have been taken by the *Oregon*. Catches have been sufficiently large to draw the interest of commercial fishermen. It now appears clearly that yellowfin tuna are available to commercial longline fishing operations in the Gulf of Mexico the year round. Present knowledge indicates that they occur in the greatest abundance in the Western Gulf and Campache areas in the late winter and spring months, and in the North Central Gulf regions in the summer and fall. The importance of a source of supply not limited seasonally is obvious in the development of a new fishery.

Several commercial vessels have already started longline fishing for tuna in the area, and the leading role in the development and utilization of this resource now rests with the industry, using the exploratory data as a point of departure. There are some problems concerned with so-called "green" tuna as are also found in other areas. However, yellowfin tuna is a well known commercial species in our fisheries and basic processing methods, market distribution, consumer education, and public acceptance do not arise as supplementary problems to the same extent as in the development of outlets for a product such as red shrimp, totally unfamiliar to the trade when first landed.

Prior to capture of the deep-water red shrimp in the Gulf of Mexico during the course of exploration by the Service's vessel *Oregon* in 1950, this species was known only through a few museum specimens. Through systematic reconnaissance, coupled with gear experimentation over the subsequent five year period, the first consistency in catches of this species was achieved in 1956.

Productive areas have now been charted in the Gulf of Mexico and off the coast of the South Atlantic States where commercially significant catches of red shrimp have been made by Service exploratory fishing vessels. These catches have aroused the interest of the fishing industry even though formidable problems are involved compared to those which were encountered in utilization of the Gulf tuna.

In the red shrimp program the Service has devoted more than usual attention to gear research and experimentation because of the unusual depths in which the species is found, and because of the unique current and other oceanographic factors encountered, particularly in the Gulf Stream area off the South Atlantic coast. Shrimp fishermen are accustomed to fishing in depths perhaps as much as 50 fathoms and, on first thought, have certain reservations about tackling a new fishery in something over 200 fathoms. There is nothing strange about this, since fishing conditions will be entirely new in these depths, costs of gear will exceed present costs, and some alterations will have to be made to the vessels.

In addition to these considerations, the fisherman who is well acquainted with producing and marketing white, brown and pink shrimp from the lesser depths is now facing an added expenditure for deep-water fishing to produce a product literally unknown to the trade.

It is for these reasons that the Service has pursued, and probably will have to continue, a more comprehensive program than in the case of the Gulf tuna development. It must be shown conclusively that there is a possibility of producing red shrimp within a margin of profit that will permit continuity of commercial operations.

Marketing experiments in cooperation with interested shrimp producers are being conducted by the Service. Test lots are being distributed to selected restaurants for reaction as to price and customer acceptance. Technological work is being conducted to determine optimum cooking times and the percentage of recovery in the cooked product. Tests to determine storage characteristics and the best means of handling the product also are being made. It is worthy of mention here that even the selection of an acceptable trade name is a matter of no small consequence in launching a new product. Some research effort has been given to that problem and our statistical bulletins and market news reports are showing the commercial catches as Royal Red Shrimp. The name embraces the characteristics of the quality, taste and appearance of this shrimp and will differentiate this particular species from other red colored shrimp that may be discovered later in the course of exploratory work. There is little doubt that development of a resource yielding a product which is wholly unknown to begin with in the trade poses research problems for which governmental assistance can be useful in a greater degree than for a known product such as the Gulf tuna.

The Service has many programs, other than these which have been mentioned, aimed at aiding the industry wherever fitting and appropriate, and these are adjusted insofar as possible to meet the most urgent requests received from the industry.

So, in summary, we hold the belief that the Government's role in the partnership is to chart the marine resources of potential value within feasible reach of our fishing fleets, to evaluate the biotic factors concerned with their occurrence, to encourage the wise utilization of these resources, and to aid in fundamental research in processing, and marketing where needed. After the Service has done these things well, we have great confidence in the fishing industry's ability to seize new opportunities and to move ahead dynamically under its own impetus.

MONDAY—NOVEMBER 26

Chairman—AGUSTIN DE LA BARRA, *President, Shrimp Association of the Americas, Mazatlan, Mexico*

Aims and Progress in Gulf Fishery Investigations' Shrimp Research

THOMAS J. COSTELLO

Fish and Wildlife Service
Galveston, Texas

CONCENTRATED FISHING for small shrimp in inside waters may be beneficial to total shrimp production. In making this rather provocative statement it is necessary to underline the word *may*. Authority for this possibility is the recently published Fishery Bulletin 106 by Milton J. Lindner and William W. Anderson: "While we have suggested that it may be advisable to limit fishing for small shrimp, on the other hand heavy exploitation from inside waters may result in a more extended spawning success owing to reduced cannibalistic predation, with the obvious consequence of greater production." It is not the purpose here to pursue this hypothesis any further. It is used simply to focus attention on the present state of biological knowledge regarding our $100,000,000 shrimp fishery. Condensed into one phrase, "We know a little bit about a lot of things."

At Galveston the Fish and Wildlife Service has well under way a shrimp research program aimed at determining which factors govern the rather broad fluctuations in shrimp abundance year by year. We have nearly completed a review of literature pertinent to the penaeid shrimp. Since 1908 at least sixty-one authors have published work dealing with penaeids in this area, and naturally the studies and conclusions reached by all these scientists are being molded into our thinking as we design the program. Also, it is only fair to say that many features of our study are by no means original; many, perhaps most of the men who have studied Gulf shrimp, have pondered the question "What causes the marked fluctuations in abundance year by year?" Gunter and Hildebrand in their paper published in 1954 relating total rainfall to the catch of white shrimp bracket but do not definitely establish one possible primary factor. Some of Albert Collier's unpublished notes and data collected in the late twenties and early thirties follow this general thinking. He wanted to see what relationship, if any, existed between the prevailing southeast winds on the Texas coast and the entry of post larval penaeids into coastal estuaries. With all the field work that has been done to date, no author has done more than broadly speculate on how larval and post larval penaeids are able to move from the spawning grounds into estuaries. Austin Williams, of the University of North Carolina Institute of Fisheries Research, in a paper published last November gives some useful data bearing on this question. Probably more important is the question "What factors determine the percentage of recruits which successfully reach the so-called 'nursery grounds'?" The answer to this particular question may be a notable contribution toward our understanding of population fluctuations and we hope to make that contribution.

We have a dual research program. In the second phase of our laboratory work, we asked the obvious question "What are the most notable gaps in our knowledge of this animal?" Anatomical information was sparse and sketchy. We called upon Dr. Joseph Young at the University of Tulane, by contract, to furnish us the needed descriptive information. His very excellent atlas of *Penaeus setiferus* is nearly completed.

Data dealing with shrimp tissue were almost non-existent and we asked Dr. Jerome Stein of Texas A. and M. to begin the histological and histochemical studies required. His first rather extensive report will be completed next month. Shrimp tagging in the past has been confined to adults. There was obvious need for a method which would allow us to mark juveniles. The assignment to devise a method was given to Charles Dawson of the University of Texas, and he has developed a staining technique which appears usable for very small shrimp as well as for adults. In the Galveston laboratory we tested Dawson's methods on 25 mm penaeids. The stain was readily discernible two months after the original staining and probably the stain, properly applied, will last several months. It was interesting to note that considerably less mortality occurred in the stained shrimp than in the control group we held in an immediately adjacent tank. Perhaps the stain is a therapeutic agent as well as a marking tool. With this new staining technique we intend to do some field work early next year which could answer several "unknowns" regarding the movement of juveniles.

In the Galveston laboratory we have completed some precise studies relating shrimp growth to temperature. Projects also include a study of shrimp nutrition, of light and oxygen requirements and comparative studies of the particular requirements of brown and pink shrimp as compared to whites. Recently we completed a series of toxicity experiments. In one we found an insecticide (Benzene hexachloride) used extensively by mosquito control groups on the Gulf coast, is toxic to shrimp in dilutions of 1 to 20 million. Mr. Chin of our Galveston staff will report this work.

The crying need is for research designed to answer specifically some of the obvious questions and thereby establish a basis upon which further research may proceed. The Gulf Fishery Investigations, as a matter of policy, will make available in published form information which may be helpful to other researchers in the field, even when a final conclusion may not be possible on the particular subject under discussion. However, our goal is to see many of the basic problems through to a final unqualified conclusion.

Intermittent Shrimp Sampling in Apalachicola Bay With Biological Notes and Regulatory Applications

ROBERT M. INGLE

Assistant Director
Florida State Board of Conservation

ALTHOUGH THE EXACT VALUE has never been conclusively established, it has been frequently believed by laymen, administrators and biologists that the protection of young shrimp is desirable. Recently evidence has been presented (Gunter, 1956) which supports this position. Various methods have been

used to achieve this protection. These include: 1. prohibition of catching or possession of shrimp of small size (count law), 2. establishment of sanctuary areas where no fishing may take place where it can be shown that nursery grounds for shrimp exist. 3. opening and closing of certain areas regularly each year by law (presumably during the time when young shrimp are maturing), 4. mesh size regulation to permit the smaller size shrimp to pass through the cod end of the trawl, and 5. administrative regulation which permits temporary fishing restrictions to be applied and removed geographically and seasonally as indicated by the size and distribution of the shrimp population.

Certain difficulties arise in the case of each of these methods. Some of the shortcomings are summarized in Table 1.

Methods 1, 2 and 3 had been tried in Apalachicola Bay for many years without notable satisfaction by the members of the industry, biologists or administrators.

Legislation in June, 1953, delegated to the Director of Conservation the authority to open and close the Bay. Sampling was begun almost at once and was carried out on an irregular basis from June, 1953, to March, 1955. Very few permanent records were kept, a rigid schedule was not adhered to, and the findings have not been available to the author.

A summary of past regulatory measures is presented in Table 2.

In March, 1955, a schedule was established and regular samplings were started. Weekly samplings were attempted, but due to weather and other factors this was not possible in all weeks. During certain critical periods, samples were obtained daily. Regular reports were filed showing date, location, and time of each sample at fourteen different stations in the Bay. White, pink and brown shrimp were designated in each case and the count (number of shrimp to make a pound) and amount caught was established.

Samples were obtained by dragging a try net (otter trawl) for a period of ten minutes at each station. The mesh of wings of the nets was one inch bar and the cod end was 3/4 inch bar (manufacturers specifications). Although several nets were used in the course of the study none was less than 20 feet in width and none was greater than 24 feet. This difference in gear makes a completely accurate quantitative evaluation of the data impossible. It is not felt, however, that the general abundance trends as presented here were seriously affected. With a few indicated exceptions, all samples were taken during daylight hours.

The author wishes to express his appreciation to conservation agents H. Griswold, W. Henderson, G. Warren and General Agent O. Clark. Special acknowledgment is made of the cooperation of Mr. Joseph Martina, whose interest and diligence were of great value.

Although the sampling is continuing, this report applies only to findings made up to October 1, 1956.

Results

The findings are voluminous and will not be provided here in detail. Complete files are maintained in the office of the State Board of Conservation in Tallahassee and are available for reference.

The following are the salient results of the study:

1). Three species of commercial shrimp were taken. These were the white

TABLE 1

METHODS OF PROTECTING SMALL SHRIMP WITH DISCUSSION OF EACH

METHOD	DESCRIPTION	DEFICIENCIES
1.	Size limit (count law)	1. Fishermen catch all sizes, can cull out small ones which, because they die, are lost to later production. 2. When small ones are caught inadvertently, fishermen argue that they should be kept inasmuch as they are already dead.
2.	Sanctuary areas	1. Although certain restricted areas may be located where small shrimp almost always predominate, they may be found in larger areas seasonally. A firmly established sanctuary would, therefore, be too small at certain times, or, if it encompassed the largest area needed, would be too large at others. 2. Fishermen contend that after shrimp leave bays many scatter, migrating to inaccessible bottoms.
3.	Open and closed seasons	1. Rigid dates would fail to accommodate to annual variations. Some years shrimp would mature and move offshore before the inshore waters were opened, in other years development of the young might be retarded and fishing would be permitted while the shrimp were still undersized.
4.	Mesh size regulation	1. Likelihood that many small shrimp still will be blocked from escaping when tows are long and nets are full of shrimp, fish and other animals and plants. 2. Possibility that in some cases mortality still might be high among the escaping shrimp. 3. In a restricted, inshore area, multiple escapements from trawls might be made by the same shrimp. This would increase the probability of being killed. 4. As mesh size increases, legal sized shrimp begin to escape. 5. Optimum size of mesh which will retain legal sized shrimp still will capture up to 66% of the smaller sizes.
5.	Temporary restrictions based upon sampling	1. Expense for regular sampling involving employees, boats, and trynets. 2. Responsibility of biologists and administrators to be cognizant of weekly findings and almost daily availability to make decisions on opening and closing of specified areas. 3. Enabling and permissive legislation giving biologists and administrators liberal authority is a prerequisite.

TABLE 2

REGULATION OF APALACHICOLA BAY FOR SHRIMP FISHING, 1937-1956

DATE	ACTION TAKEN	BASIS	REMARKS
Feb. 1, 1952	Closed	Statute	This regime was followed each year after 1937
April 1, 1952	Opened	"	
August 1, 1952	Closed	"	
Oct. 1, 1952	Opened	"	
Feb. 1, 1953	Closed		
April 1, 1953	Opened		
June 30, 1953	Opened	Night	Under new law, the Director can open and close
August 4, 1953	Closed	By popular request	
Sept. 8, 1953	Opened	Sampling	
Aug. 6, 1954	Closed	Sampling	Sampling not rigidly scheduled
Aug. 29, 1954	Opened	Sampling	" " " "
Aug. 13, 1955	Closed	Based on Sampling	
Oct. 3, 1955	Opened	Based on Sampling	
Dec. 10, 1955	Closed	" " "	
April 18, 1956	Opened	" " "	
Aug. 18, 1956	Closed	" " "	
Sept. 8, 1956	Opened (night only)	" " "	Only south part of Bay open
Sept. 19, 1956	Opened (night & day)	" " "	

shrimp, *Penaeus setiferus,* the brown shrimp, *Penaeus aztecus,* and the pink, or spotted shrimp, *Penaeus duorarum.* Monthly summaries of abundance and size of each of these species are provided in Tables 3, 4, and 5. The ranges expressed under "Remarks" refer to the largest counts and smallest counts of entire samples, not to sizes of individual shrimp.

2.) No seabobs *(Xiphopeneus kroyeri)* were encountered during this study, although they have been produced commercially in waters offshore.

3.) No rock shrimp *(Sicyonia)* were encountered, although they have been produced commercially in waters offshore.

4.) In a few instances drags were made in the day time and followed by duplicate drags, in the same locality, at night. The results, as expected, showed a nocturnal periodicity for brown shrimp. Duplicate day and night sampling was not made during times of occurrence of small sized browns. No information is therefore available as to whether the small shrimp of that species is less photo-sensitive than the large ones. At the time the night trawls were made, pink shrimp were rare in the Bay and no comparative results were obtained on that species.

5.) Shrimp sizes and abundance are summarized in Tables 3, 4 and 5. In these tables the following definitions obtain: rare, less than ten; few, 10-55; common, 55-100; abundant 100 and over; legal, 45 and under; illegal, 46 and above. All counts per pound refer to shrimp with heads on.

TABLE 3

SIZES AND ABUNDANCE OF WHITE SHRIMP, *Penaeus setiferus*

1955

MONTH	AVE. SIZE	AVERAGE ABUNDANCE	REMARKS
March	Legal	Few	Range 25-40 Most were 40 count and under. Ave. count 36
April	Legal	Few	Average count 30-35. Range 25-40
May	Legal	Few	Average count 25-30
June	—	None	—
July	Illegal	Rare	Ave. count 85-95. Range 70-110. Five samples had counts of 100 or more
August	Illegal	Common	Ave. count 90-95. Range 50-110
September	Illegal	Abundant	Many samples were legal by the end of the month. Ave. count for month 59. Range 40-110
October	Legal	Few	Bay was opened Oct. 3. Ave. count for month 39. Range 30-70
November	Illegal	Rare	Two samples in East Bay were of 100 and over count and were extremely abundant. Ave. count all other stations was 62. Range 55-100
December	Illegal	Rare	Only 3 samples yielded any shrimp All were 100 and over count and rare. Most samples were negative.

1956			
January	—	—	No samples taken
February	Illegal	Rare	Only seven shrimp caught during month. These averaged 78 count. Many samplings were negative.
March	Legal	Rare	All counts were 39-41 except one which was 36. Several samplings were negative.
April	Legal	Few	Average count 40. Very narrow range of variation in count. Few tries were negative.
May	Legal	Rare	With exception of one sample of count 80, all other samples averaged 27. Range 25-80.
June	Legal	Rare	Only one white shrimp was caught during month. It was 30 count.
July	Illegal	Few	Average count 80. Average number caught 14. Range 60-100
August 1st half	Illegal	Common	Average 63 count. Range 30-100
August 2nd half	Illegal	Abundant	Ave. count 66. Range 35-100. A few samples were negative.
September 1st half	Illegal	Abundant	Ave. count 48. Range 30-70. Many tries were negative.
September 2nd half	Legal	Abundant	Ave. count 43. Range 15-80. Many tries were negative. Those that were positive had such large amounts of shrimp that the ave. catch was classed abundant. Bay was opened for fishing.

Discussion

Penaeus setiferus

The white shrimp appear to fit a seasonal pattern as follows:

1. *Winter.* A few small individuals stay in the Bay during the cold months (November-February). The slow growth of small shrimp which winter in the bays has been well established (Lindner and Anderson, 1956; Gunter, 1950; Williams, 1955) and is further demonstrated here by the sustained small size of individuals caught during November, December and February.
2. *Spring.* During early spring there is apparently a fairly rapid growth and a movement offshore (March-June). The offshore migration was particularly noticeable during the month of June. Only one shrimp was caught in the Bay during that month in 1956 and none were caught in 1955. There may have been recruitment of very small juveniles during June which were not caught because of the relatively large size of the trawl mesh.
3. *Summer.* Although the growth of white shrimp in the summer has been shown to be rapid (Lindner and Anderson, 1956; Williams, 1955), the size of the shrimp caught increased relatively slowly in Apalachicola Bay.

TABLE 4

SIZES AND ABUNDANCE OF *Penaeus aztecus*

MONTH	AVE. SIZE	AVERAGE ABUNDANCE	REMARKS
1955			
March	—	None	—
April		None	—
May	Illegal	Abundant	Average 82 count. Size range 65-95. Present in all stations.
June	Illegal	Common	Average 51 count. Range 25-80.
July	Legal	Few	Average 40 count. Range 25-90. Average number per drag 23.
August	Legal	Few	Average 39 count. Range 25-50. Several samplings were negative. Ave. 13 shrimp per drag.
September	—	None	—
October	—	None	—
November	—	None	—
December	—	None	—
1956			
January	—		No samples taken
February	—	None	—
March	—	None	—
April	—	None	—
May	—	None	Only one set of samples taken during early part of month.
June	Illegal	Few	Average count 52. Range 40-55
July	Illegal	Few	Ave. count 47. Range 35-60. Several trawls were negative.
August	Illegal	Rare	Ave. count 55. Although trawls were made almost daily during much of the month, only four samples contained brown shrimp.
September (day)	Illegal	Rare	Ave. count 54. Many samples neg.
September (night)	Legal	Few	Ave. count 31. Encountered shrimp in each drag. Average 15 per drag.

The first young individuals appeared in July. Presumably these were produced offshore during June when mature shrimp are almost nonexistent in the Bay. In July the count of all shrimp taken averaged about 90. The legal count of 45 was not reached until October in 1955, and the third week of September, 1956.

It is assumed that the reason for this apparently slow development was recruitment of juvenile shrimp which tended to mask the rapid growth of the larger individuals.

It was not possible in the present study to find evidence of two or more separate and distinct spawnings. It seemed rather that spawning proceeded throughout the summer until October.

The present methods were sufficiently gross that separate spawnings might have taken place without being discovered and this possibility

TABLE 5

SIZES AND ABUNDANCE OF *Penaeus duorarum*

MONTH	AVE. SIZE	AVERAGE ABUNDANCE	REMARKS
1955			
March to November	—	None	No pink shrimp encountered during this period.
December	Illegal	Rare	Three drags positive out of eleven made. Average count 70.
1956			
January	—	—	No drags made
February	Illegal	Rare	Two drags positive out of 13 drags made. Ave. count 90. Ave. number caught 5.
March	Illegal	Rare	Six drags of 15 were positive. Ave. count 51. Ave. number caught (of positive drags) was 9.
April	Legal	Few	Two drags of 17 made were positive. Ave. count 35. One sample had 4 shrimp and other had 50.
May	Legal	Rare	Two drags of eleven were positive. These two drags were both of 25 count and 2 shrimp each.
June	—	None	—
July	Legal	Rare	6 drags of 50 were positive. Ave. count 45. Ave. number caught in positive samples 2.
August	Illegal	Rare	Two samples of 33 were positive. Both positive samples taken during first part of month. Count of one sample 70, the other 25. Both samples contained 2 shrimp.
August (night)	Legal	Few	Ave. count 38. Ave. number caught 14. All drags (9) were made 8/23-/56 in Eastern end of Bay (Porters Bar-Cat Point). They were not encountered at any other time although drags were made on several nights (see brown shrimp data).
September	—	None	—

should be kept in mind in view of evidence that multiple spawnings or at least multiple entries into the bays do exist (Gunter, 1950).

4. *Fall.* Recruitment of juvenile shrimp apparently continued until the onset of cooler weather (about the middle of September to the first of October). The count is high after the larger individuals migrate out of the Bay in late summer and fall, leaving the smaller sizes. The offshore fall migration of adults has been well established by others (Lindner and Anderson, 1956; Williams, 1955) and is evidenced by the offshore

activity of the Apalachicola commercial fleet in the fall.

The findings of this study are in general agreement with established theories of white shrimp biology. Abundance trends are similar to those noted in Alabama (Loesch, 1954 and 1955). A small sized, apparently slow growing, and not very abundant population winters in the Bay. This has been noted by others (e.g., Weymouth, Lindner and Anderson, 1933; Lindner and Anderson, 1956). Beginning in March, growth seems to be rapid. Then, in June, all large shrimp leave the Bay, presumably to spawn.

Earlier spawnings may take place and very small shrimp may enter the Bay earlier as a result, but the nets used in this study were probably too gross to catch them. At any rate very small shrimp, presumably from the spring spawning, appear in the Bay in July and August.

If we assume that shrimp of small size can double their weight in 7-10 days' time (Gunter, 1956), then the findings indicate that steady recruitment of juveniles probably takes place from June or July to October or November to elevate the count of shrimp caught. This belief is bolstered by the wide size ranges encountered.

The high count may also be sustained by the migration out of the Bay and into more saline water of the larger individuals as suggested by other workers (e.g., Weymouth *et al.*, 1933; Gunter, 1950).

By the end of September or the first part of October, recruitment apparently slows to the point that growth of already-present shrimp is able to reduce the count to legal limits.

There seems to be a brief period in the fall when the Bay has enough legal sized shrimp to permit trawling. Within about one month or less, the larger shrimp move offshore and out of the Bay fishery leaving the smaller ones behind. This results in an elevated count and closure of the Bay.

The law, as it existed from 1937 to 1953, probably was adequate for opening the Bay for fall shrimping, although annual variations would have been neglected. But no provision was made for the protection of the diminished number of small shrimp which winter in the Bay, unless the meager population of inferior size prevented shrimping because of impracticality.

The 1937-53 law allowed shrimping of the small number of large shrimp in the late spring. This practice has also been permitted, at times, since 1953. These shrimp presumably form part of the summer spawning population (Lindner and Anderson, 1956) and if numbers of spawners were deemed to be critical, should be protected.

Penaeus aztecus

The seasonal pattern set by the brown shrimp was not as consistent as that shown by the white shrimp. However, a few general observations were made. These follow:

1. *Winter*. Between September 1, 1955, and June, 1956, only three samples, all taken on the same day in February, 1956, were positive for brown shrimp. The abundance in each case was rated rare and the counts of all three were 70.
2. *Spring*. Brown shrimp were not found during the early spring (March and April). Small shrimp entered the Bay abundantly in May, 1955. If these were the results of the year's first spawning, then it must be assumed that brown shrimp spawn in this area before the white shrimp.

In 1956, this spring appearance was delayed a month but the shrimp were larger, being about the same count as those encountered in June of the previous year. This would indicate that spawning had taken place at about the same time in both years but that the younger individuals either did not enter the Bay as early, or, if they did, they were not encountered by drags which were made. The latter is quite possible inasmuch as only nine stations were visited during May, all of them early in the month and on the same day.

3. *Summer and Fall.* During the summer, the count and abundance of shrimp caught goes down. The decrease in count probably means that the shrimp are growing. The count is legal in September, after which the numbers diminish rapidly. In September, 1955, none were found and in the same month, 1956, very few were encountered except in the distal parts of the estuary at night, in deeper, saltier water.

   The decrease in numbers might be explained in two ways: 1. an actual decrease in numbers due to mortality or migration to offshore waters, or 2. a greater negative reaction to light with increased size resulting in a greater tendency toward nocturnal periodicity. In the second alternative, an explanation could be found for the great numbers of small brown shrimp taken in the daytime earlier in the year.

   It has already been established that adult brown shrimp may be relatively abundant and yet not be caught in the daytime. The present alternate night and day trawls confirm this fact.

   Night and day trawls in the spring, directed toward small brown shrimp, might give an indication of degree of nocturnal periodicity in the immature stages.

From September, 1955, to April, 1956, inclusive, no brown shrimp were encountered in the Bay. This corresponds with the findings of other workers (e.g. Gunter, 1950; Williams, 1955).

In May of 1955, small (average count 82) brown shrimp entered the Bay in abundance. In 1956, only one set of samples was taken during May, during the first week. It is quite possible that the same sudden appearance of immature brown shrimp in May occurred in 1956, also.

At any rate, the count of both years was the same for June, indicating the same spawning time in 1955 and 1956. Abundance trends are similar to those given for Alabama (Loesch, 1954 and 1955).

In North Carolina young adults appear suddenly in the estuaries in June (Williams, 1955). Williams states that these young shrimp had been on the nursery ground in shallow water for about two months before moving into deeper, fishable waters.

Since the primary and most consistent nursery grounds in Apalachicola Bay are north of Gorrie bridge where samples were seldom taken, no information is available as to whether the young which were first caught in the Bay in May and June had just entered from outside or whether they were moving from more shallow nursery grounds to deeper water as they grew.

In Alabama, as in North Carolina, the very small brown shrimp are found in shallow water, i.e., two to three feet (Loesch, 1954).

By July the young shrimp were legal sized (or nearly so) and by the beginning of September appeared to be leaving the Bay. The expression "appeared to be" is used because night samples were often positive when

duplicate samples, taken during the day, were negative.

It is reasonably certain that the shrimp did leave the Bay, at least by the middle of September, 1956. After several night samples showed the advisability of doing so, the Bay was opened for night shrimping on September 8, 1956. Before the fleet could take advantage of the opening most of the shrimp had departed, making it unprofitable to fish.

Night trawls taken during winter months will yield information as to the true or apparent absence of brown shrimp from the Bay during the winter.

Penaeus duorarum

There was hardly a discernible pattern of any kind with the pink shrimp. None were found from March until December, 1955.

1. *Winter.* Rare, small and illegal sized pink shrimp were found in the Bay from December, 1955, until March, 1956. The count appeared to decrease during that period.
2. *Spring.* A continued decrease in count was seen from March to May, 1956. Although few were encountered, those shrimp taken in April and May were legal.
3. *Summer.* The rare individuals captured during July and August, 1956, had a wide range of sizes. None were taken during June.
4. *Fall.* In 1955, none were caught from September to December. In 1956, none were encountered in September, the last month covered by this report.

The lack of any particular pattern in occurrence of the pink shrimp is not unique to Apalachicola Bay. Studies in Alabama indicated its occurrence as "sporadic" and in such small numbers that a pattern was not identifiable (Loesch, 1954).

It is hoped that as the present study continues and more information is available, consistencies will begin to appear which will allow interpretation. It is thought that night trawlings taken throughout the year will be especially instructive. In the meantime, possible explanations for the rather meagre, transitory and unpredictable nature of the pink shrimp population might be found in the conclusions of others.

It has previously been noted that *P. duorarum* prefers waters of a rather high salinity and extensive vegetation for cover (Hildebrand, 1955). Since the salinity of Apalachicola Bay is subject to frequent and relatively great fluctuations in salinity (Ingle and Dawson, 1951), migration in and out of the Bay might be a response to favorable and unfavorable salinities.

Pink shrimp also prefer calcareous sediments, whereas the white and brown seem to seek muddy bottoms (Hildebrand, 1955). The absence of calcareous sediments in the Bay might help to explain the paucity of pink shrimp.

SUMMARY

1. Biological notes are provided for white, brown, and pink shrimp.
2. The information on the white and brown shrimp is in general agreement with the findings by other workers in different localities.
3. Scanty numbers and lack of seasonal pattern made difficult any interpretation of data on pink shrimp. Possible explanations for small population

and unpredictable appearance are advanced. It is suggested that night trawlings might be instructive.

4. The history of shrimp regulation in the Bay is provided. Shortcomings of a rigid open and closed season are presented.
5. A system of continuous checking has been in use for a year and a half. The findings of this study have been used to regulate the fishery as follows:
   1. Bay was opened at night only when size of brown shrimp was legal.
   2. Bay was opened for day fishing when size of white shrimp was legal.
   3. Bay was closed when size of brown and white shrimp was illegal.

The chief asset of this method of regulation is flexibility. Such flexibility is needed when dealing with three separate species all of which have different habits and periodicities and which may mature at different times. Also, since the maturation of shrimp is probably a result of many inter-acting factors, the migration, growth, reproduction and other processes cannot be expected to follow a rigid schedule. A system of continual sampling allows for regulatory accommodation to developments on the shrimp beds.

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Mesh Size Regulations as a Possible Method of Managing the Tortugas Shrimp Fishery

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Introduction

"Florida Landings" (1950-1956) show the Tortugas pink shrimp (*Penaeus duorarum*) to support one of Florida's most valuable fisheries. The discovery of this population in 1949 and its subsequent exploitation has created an industry employing several hundred boats yearly. The fishing grounds lie north of a line drawn from Key West to Loggerhead Key in the Tortugas group. The area is about 70 miles long and 20 to 25 miles wide. There is some fishing west and northwest of the Tortugas in waters deeper than 21 fathoms, but the majority of the fishing is done in 14 to 20 fathoms. In addition to the Key West fleet, boats from Tampa, Ft. Myers, Everglades, Naples, Marathon, and other Florida ports fish the grounds. Boats from Georgia, North and South Carolina and several other states also fish the Tortugas, usually selling their catch in Key West. A few Cuban boats also work the grounds.

A reported decline in the landings of larger shrimp and possible depletion of the stocks caused by landing quantities of small shrimp (70 count and above, heads off) led the Florida State Board of Conservation to ask The Marine Laboratory of the University of Miami to make a study of the problem. Experiments begun in October 1955 were primarily concerned with net selectivity and were designed to provide an interim measure until further investigations would reveal the basic aspects of the biology of the shrimp, especially growth and mortality rates, necessary to reach a permanent solution. It cannot be overemphasized that we are not in a position to decide whether it is more desirable, economically and biologically, to catch shrimp at a small size or whether it is better to let them grow bigger. Work necessary to make such decisions is already underway, both at the University of Miami and other laboratories.

Specifically the purposes of the present study were:

1. To study the effect of different cod end mesh sizes on the size composition of the catch and the escapement of shrimp.
2. To determine the effect on small shrimp of passing through the cod end.

Acknowledgments

The authors gratefully acknowledge the cooperation of Captain Andrew E. Downing, upon whose vessel *Manboy* all of the regular monthly work was carried out. The Gear Research and Development Section of the U. S. Fish and Wildlife Service generously gave aid and the facilities of their research vessel the *George M. Bowers* to help complete several important phases of the work. The cooperation and aid of this section, and especially of Messrs. Reidar F. Sand and James B. Higman, are gratefully acknowledged.

Methods and Equipment

The vessel *Manboy* out of Key West, owned and captained by Andrew E.

[1]Contribution No. 179 from The Marine Laboratory, University of Miami.

Downing, was used for all the regular monthly field work. She is 110 ft. in length and has a 14 ft. beam. While not a shrimp boat by design, there is no reason to believe that a trawl operated by the *Manboy* will perform any differently with regard to net selectivity than that operated by a "typical" shrimp boat. Our objective was not to see how many shrimp could be caught, but rather, what sizes would be caught and what sizes escaped through the meshes of the cod ends. The experiments are valid if the net sampled all sizes in the proportions that they occur on the grounds. The boat is only a machine to pull the net. A big boat with more power can perhaps catch more shrimp, but there is no evidence to show that it will catch different sized shrimp than are on the grounds. Greatly different trawling speed might affect sizes of shrimp caught by catching more of the faster animals. *Manboy* trawls within the range of the normal speed of regular boats.

The otter boards, or doors, used to spread the net were nine ft. long by three ft. four in. high. The bridles leading from the doors to the wings of the trawl were 15 ft. long. The trawl used was a standard 100 ft. Florida balloon shrimp trawl. A tickler chain was employed between the doors. The opening at the mouth of the trawl was about 69 feet. Four cod ends of different mesh sizes were used during the course of the work, 1¾″, 2″, 2¼″ and 2½″. These are manufacturer's measurements which were taken at the midpoints of knots. They were all made of 42 thread cotton twine. The trawl and all of the cod ends were treated with a creosote preservative before use, just as are nearly all nets used commercially in the fishery.

The cover bag used to catch the escaping shrimp and trash was sewn to the cod end about 12 meshes below the place of attachment of the cod end to allow room for the operation of the lazy line. It covered the entire cod end and extended three to four ft. beyond the end of the cod end. It was made of cotton twine with one in. stretched mesh which shrinks after first immersion to between ¾ and ⅞ in.

Fishing was done on two successive nights during the first two weeks of each month, except when inclement weather made postponement necessary. Three hauls were made each night of two hours duration over a standard sampling pattern consisting of six stations which ranged in depth from 70 to 95 ft.

The net was set and retrieved just as in a regular commercial operation. When the cod end was swung on deck at the end of the drag the cover bag was first opened and the catch from it deposited in a basket which was set aside. Then the cod end was opened and its catch allowed to fall to the deck. Estimates were made of the weight of the total catch, of the shrimp alone and of the trash, both by the skipper and the scientist on the vessel. Shrimp fishermen are fairly accurate at estimates of this type, since their livelihood depends to some extent on these estimates. A sample of the cod end catch was chosen at random, since it was impractical to measure all the shrimp taken and an estimate was made of what proportion this sample was of the total. As a rule all the shrimp from the cover bag were returned for measuring.

A head length measurement was taken from the orbital notch inside the orbital spine in a line parallel to the lateral rostral sulcus to the caudad margin of the cephalothorax. This measurement was taken with calipers to the nearest millimeter. The rostrum of a shrimp may be broken off and regenerate; thus if total length had been used, some error may have been introduced due to the variation in the length of the regenerating rostra. Measuring the total length also presents an added difficulty when working with shrimp preserved in forma-

fin. There is usually some amount of curve in the abdomen which is almost impossible to straighten out without breaking the animal in two. The relationship of carapace length and count per pound, heads off, was determined. All counts given are heads off.

For holding live shrimp on board the *George M. Bowers* a wooden tank of about 11 cubic feet was used. This was placed upon the deck of the vessel and supplied with sea water at the rate of about four gallons per minute.

Effect of Different Mesh Sizes on Catch

First it was necessary to determine if the various sized meshes (1¾″, 2″, 2¼″, 2½″) caught different sized shrimp. To accomplish this the numbers of shrimp of each size in the cod end and cover bag were added together and plotted for each sample (Figure 1). A curve was then drawn through the average points. This represents the sizes and relative numbers of the total population of shrimp available. The curve shows that in each set of samples the sizes available were much the same. This means that small shrimp were always available on the ground to escape.

To show the escapement of the various sizes of shrimp for each size of net the number of shrimp in each size category in the cod end was compared with the number in the same size category in the cover bag. Then the percentage of the shrimp in the cover bag and those in the cod end and cover bag added together, for each size shrimp, was plotted. The broken line in Figure 1 is the average curve for these points.

Since the relationship shown between the escapement and total catch curves depends in part upon the ability of the observers accurately to judge the proportion of the total catch constituting their sample, the validity of these estimates was examined. If the estimates of the proportion which the sample was of the total in the cod end had been of a random nature, sometimes too high and sometimes too low, then it should be expected that an average curve would result which would approximate the true situation. On the other hand, if the percentage escapement figures of all sizes of shrimp for individual months fell entirely below or above the average curve it would indicate that estimates of total catch in the cod end vary greatly from month to month. It was found in plotting the data that escapement points for each of the various months fell both above and below the average curve for each of the sizes of shrimp. Therefore it seems likely that the variation of the escapement of the different sized shrimp had a greater effect from sample to sample than did the estimates of total catch.

It can be seen in Figure 1 that the variability about the average escapement points is not great and we believe that our samples, taken at different times of the year, have provided reliable averages.

Escapement

That different size meshes in the cod ends caught different sized shrimp, and that approximately the same sizes were available to be caught during each month, has been shown. The next step is to determine what percentage of the various sizes escaped, and what percentage of these sizes were available to escape. Considering first the 1¾″ mesh samples taken October, November, and December, we see that the 110 count shrimp (18 mm) are so few, (only five per cent of the total catch) that the 10 per cent of this group that escapes is not important. Of the 83 count shrimp (23 mm) nearly five per cent escaped,

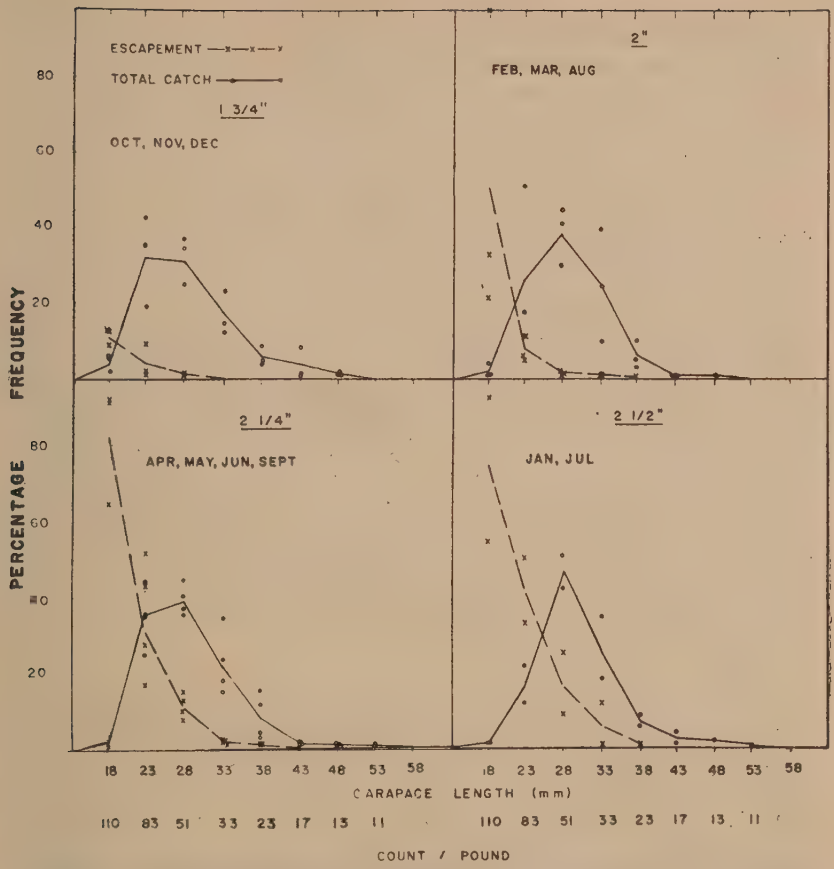

FIGURE 1. Size distributions of pink shrimp in the cod end and cover bag combined and escapement through the cod end.

and about 30 per cent of the total catch was made up of this size. Shrimp of 51 count (28 mm) and larger showed no escapement. The 2″ mesh cod end was tested during February, March, and August. Again, although escapement of 110 or greater count shrimp is high (50 per cent), so few were taken it can be ignored. In fact, this is true for the escapement of shrimp in this size category for all mesh sizes tested. The 83 count shrimp (23 mm), which formed about 30 per cent of the catch, show an average escapement of 10 per cent and practically no escapement of 51 count (28 mm) and larger.

There is a rather sharp change in the escapement from the 1¾″ and 2″ cod ends when the escapement of the 2¼″ mesh cod end during April, May, June, and September are examined. Approximately 35 per cent of the catch was made up of 83 count shrimp (23 mm) and of this amount this cod end allowed about 30 per cent to escape. Of the 40 per cent of 51 count shrimp (28 mm)

present in these catches about 10 per cent escaped. None of the 33 count (33 mm) or larger escaped through the meshes.

The 2½″ mesh cod end used during January and July in general shows a slightly higher escapement than the 2¼″ mesh cod end. The 83 count (23 mm) shrimp, which make up about 17 per cent of the catch, show an escapement of 40 per cent. Of the 47 per cent of the 51 count shrimp (28 mm) it can be seen that about 15 per cent escape. About five per cent of the 33 count (33 mm) escape and these made up about 26 per cent of the catch.

It can be concluded from these results, that to allow an appreciable number of small shrimp to escape a minimum mesh size of at least 2¼″, manufacturer's measure is required and 2½″ is too large.

Effect of Passing Through the Meshes of a Net

The question can reasonably be raised that even if small shrimp are allowed to escape, will they live after escapement? A test was therefore conducted to determine the mortality or damage to shrimp which pass through the meshes of the cod end of a trawl. To answer this question, 35 small shrimp that had passed through the 2¼″ mesh of the cod end and were found in the cover bag after four hauls of 1½ to 2 hours duration were placed in the tank on deck of the Fish and Wildlife Service vessel *George M. Bowers.* During the observation period the shrimp swam about and appeared to be in good condition. Although the antennal flagella of most were found to be damaged after the experiment was terminated approximately 92 hours from the time the first shrimp was added, all lived to the end of the experiment.

From this it would seem that passing through the meshes of an otter trawl apparently does not harm small shrimp.

Sex Ratio

These experiments revealed the fact that a regulation which involves an increase in mesh size from that presently used in the fishery may well alter the ratio of sexes in the commercial catch. It has been demonstrated by Williams (1955) that the female *Penaeus duorarum* in North Carolina are larger than the males and this tendency is also clearly evident in our data. Thus, as the mesh size increases more and more males are released and the proportion of females to males in the catch increases. At this time we do not know the magnitude of this change or what effect it may have, in fact it may be very difficult or impossible to test what effect it would have, on the fishery. It is a factor to keep in mind when studying the effects of this regulation.

Conclusion

It has been demonstrated above that a method for preventing capture of small shrimp is by regulation of the mesh sizes of commercial trawls. The experiments showed that the 2¼″ manufacturer's measure net would best serve this purpose because it releases significant numbers of small shrimp and few of the larger shrimp. The escaping shrimp appear to pass through the meshes of nets with little or no injury.

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Biochemical And Bacteriological Methods For Determining Shrimp Quality

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The biochemical activities of microorganisms in marine products have been extensively studied for a number of years, but the bacteriology and the biochemical activities of bacteria in shrimp and shrimp products have received only limited attention (1, 2, 6, 14, 15).

Laboratory work was carried out to determine the validity of certain tests in detecting the sanitary conditions and changes of quality in frozen breaded shrimp due to bacterial, chemical and physical factors. The study was based on samples of frozen breaded shrimp collected at packing plants and retail outlets over a two-year period from 23 cities.

In order to determine total number of bacteria in the shrimp, the media recommended by Green (6), Williams and associates (14, 15) and Bennett *et al.* (3) were studied. The method of the American Public Health Association "Standard Methods for the Analysis of Water, Sewage and Industrial Wastes" (12) was used to determine and isolate the coliform bacteria. The enterococci (fecal streptococci) were best enumerated and isolated by the use of azide dextrose broth and ethyl violet broth, Litsky, Rosenbaum and France (10) and Larkin, Litsky and Fuller (7, 8, 9).

To obtain the total number of bacteria in frozen breaded shrimp, the Nutrient Agar, 1.5 per cent, was most satisfactory and is recommended. In determining the number of coliform bacteria, the "Most Probable Numbers" is recommended. However, the use of Violet Red Bile Agar (Difco) is equally satisfactory and much more rapid (18-24 hrs.). In no instance was the presence of *Escherichia coli* confirmed by the use of Eosin Methylene Blue Agar. Therefore, little information of value is gained from making confirmed *Escherichia coli* tests.

Out of survey samples collected from 23 cities, distribution of bacteria varied from a minimum of 21,500 bacteria per gram of shrimp to a maximum number 54 million bacteria per gram. Seven per cent contained less than 100,000 bacteria per gram. Thirty-six per cent contained less than 500,000 bacteria per gram. Out of the total samples, sixty-one per cent had a bacterial content of less than 1 million.

The number of coliform bacteria varied from a minimum of zero to 700 per gram of shrimp. Out of 144 samples, only 98 (68 per cent) contained coliform bacteria, but of these 98 samples, 90 (92 per cent), contained less than 100 coliforms per gram.

Enterococci were present in all the samples and their number varied from very few bacteria per gram to 13,500. Forty-four per cent contained less than 100 enterococci per gram of frozen breaded shrimp.

To study the biochemical aspects of the spoilage of shrimp, many analytical methods were applied. Indole determination (4), iodine titration (13), trimethylamine (5), and Photoelectric Reflection Number appeared to be of neg-

ligible value in estimating the degree of freshness in frozen breaded shrimp. The only test that showed a definite correlation with the taste panel score and the logarithm of the total bacterial count was the ratio of total volatile bases (TVB) to total nitrogen (TN), multiplied by 100 (TVB/TN x 100).

Details of the procedure used to determine this ratio follow: *Total Volatile Bases (TVB) calculated as ammonia:* The sample of frozen breaded shrimp was passed twice through a clean food chopper. Five gram portions were weighed in waxed paper cups or beakers. Waxed cups were used to facilitate the washing of the sample from the container. Frozen breaded shrimp upon thawing became very sticky due to the presence of starch in the breading. The sample was washed into a Waring blender with a 100 ml. of CO_2—free distilled water. The mixture was blended for five minutes at high speed and quantitatively transferred to a 500 ml. Pyrex tapered glass-stoppered distillation flask by washing with approximately 100 ml. of distilled water. The distillation flask was quickly connected to a glass tapered Liebig condenser after the addition of approximately 10 ml. of a 40 per cent NaOH solution, boiling stones, and a few drops of Dow Corning AF Antifoam Emulsion[1]. The tip of the condenser was dipped in approximately 15 ml. of four per cent boric acid solution in which Tashiro's indicator[2] has been added. The distillation was carried out with a low flame and lasted five minutes after the appearance of a green color. The tip of the condenser was rinsed with CO_2—free distilled water and the distillate was titrated with a 0.05 N standard HCl solution. The results were calculated as milligrams or grams of NH_3 per 100 grams of frozen breaded shrimp. Many trials showed the average per cent recovery of TVB was 95.0 per cent.

Total Nitrogen (TN): The total nitrogen (TN) was determined by the Kjeldahl method using a micro-Kjeldahl digestion and distillation apparatus. The digestion mixture used was prepared as recommended by Peters and Van Slyke (11), but the addition of copper sulfate was omitted and replaced by selenized granules added directly to the digestion flask. The results were calculated as g. of nitrogen per 100 g. of frozen breaded shrimp.

Ratio of Total Volatile Base (TVB) to Total Nitrogen: The results obtained for Total Volatile Base (TVB) and Total Nitrogen (TN) were used to calculate a ratio. In order to facilitate further calculations and manipulations, the ratio was multiplied by 100.

The results obtained showed a definite correlation with the average taste panel score and the logarithm of total bacterial count. Considerable variations were obtained in the Total Volatile Bases content of different lots and of individual samples within a lot. These variations could be accounted for by the combined variation in per cent breading, moisture and mainly the total nitrogen of the lots and individual samples within a lot.

The ratio (TVB/TN x 100) when plotted against time showed a curve which could almost be satisfied by a cubic equation. The ratio was found to increase in the samples undergoing the storage test, from a value of 6.0 to a value of 7.4 where it remained stationary and then increased to a ratio value of 10.0. On the basis of the correlation with the average taste panel scores, four zones were depicted in relation to a critical ratio value of 8.0 which corresponded to a critical point for quality of frozen breaded shrimp.

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[1]Dow Corning Corporation, Midland, Michigan.
[2]0.248 g. methylene blue and 0.375 g. methyl red in 300 ml. 95 per cent ethyl alcohol.

The zones were interpreted as follows for frozen breaded shrimp:

Ratio Values	*Quality*
Below 6.0	Very Good
Between 6.0-7.5	Good
Between 7.5-8.5	Questionable
Higher than 8.5	Unacceptable

To test how realistic the proposed ratio values for frozen breaded shrimp quality were, analyses were carried on 144 samples of frozen breaded shrimp collected from 23 cities. The ratio of TVB to TN x 100 varied between 4.5 and 12.8. On the basis of the quality scale proposed, 10.4 per cent of the samples scored higher than 8.5 (Unacceptable), 25.0 per cent between 7.5 and 8.5 (Questionable), 47.2 per cent between 6.0 and 7.5 (Good), and 17.4 per cent below 6.0 (Very Good). The results were analyzed for the skewness of their distribution and a skewness value of + 0.19 was obtained. This value for the skewness indicated that the distribution of the ratio values were very close to the symmetrical distribution that was hypothetically expected. It corroborated the realistic value of the ratio as a measure for the degree of freshness of frozen breaded shrimp. Preliminary work carried out on other shrimp products indicates that the ratio not only could be used as a measure of quality for frozen breaded shrimp, but also for seafoods and meat products in general, providing the ratio limits be correlated to quality for each specific product. It is expected that the objective values of the ratio limits will vary with the type of animal product.

SUMMARY

Tentatively a total count of more than a million bacteria per gram means frozen breaded shrimp of low sanitary quality, while one in excess of 2,000,000 means shrimp of questionable sanitary quality. It seems that the enumeration of enterococci is a better index of sanitary quality than coliform bacteria. The ratio of TVB/TN x 100 indicates the closest relationship to the quality of frozen breaded shrimp and is recommended as the objective chemical test of choice.

The following quality scale is recommended for frozen breaded shrimp: A ratio value larger than 8.5 indicates an unacceptable product. Values between 7.5 and 8.5 correspond to a questionable quality. Between 6.0 and 7.5, the product is good and below a value of 6.0, very good.

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The Effect of Chlortetracycline on Shrimp Spoilage at Various Temperatures

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As for other fisheries products, quality is of prime importance in the shrimp industry. In this report two aspects of the quality problem are discussed, namely, the objective assessment of the quality of shrimp and the prolongation of the quality during handling and storage.

A number of reports have been published on the assessment of the quality of shrimp, among which may be mentioned those by Campbell and Williams (1952), Duggan and Strasburger (1946), Fieger and Friloux (1953), and

Lane and Whittaker (1953). None of the commonly used tests have proved to be of general applicability for evaluating early stages of spoilage of shrimp, where even the organoleptic judgments also vary with personal opinion and other physiological and psychological factors. In this report experiments are cited on the applicability of the content of volatile reducing substances (VRS), total volatile nitrogen (TVN) and of trimethylamine nitrogen (TMN) as measures of the state of preservation of shrimp. The VRS method has been shown to be a useful objective method to supplement and extend the value of organoleptic judgments. The content of TVN and TMN proved to have a more limited significance for the evaluation of the early stages of shrimp spoilage.

Refrigeration by ice or by cold brine has been shown by Dassow (1953), by Higman and Idyll (1952), and by Higman, Idyll and Thompson (1953) to prolong the storage life of fresh raw shrimp. Ice containing antibiotics, such as chlortetracycline (CTC), sodium chloride brine or seawater containing CTC used as a dip for shrimp, have been shown by Higman, Idyll and Thompson (1953) and by Camber (1955) to prolong significantly the storage life of raw shrimp under certain conditions beyond that of control lots. In this study the action of CTC in sodium chloride brine as a dip is reported under such categories as the effect of concentration of CTC, of dipping time and of peeling the beheaded raw shrimp.

The shrimp available for this study were mainly frozen Mexican white or brown shrimp from Lower California, with some frozen Gulf of Mexico white shrimp from Texas. These were obtained as 5 lb. glazed blocks of beheaded whole or unpeeled shrimp. They were thawed at ambient temperature for use. A stock 0.1 per cent or 1000 p.p.m. solution of CTC in distilled water was diluted with 5 per cent sodium chloride solution to give the desired final concentration of antibiotic. The shrimp were immersed in the dilute antibiotic or in plain salt solution for a specified time, separated by decanting and draining, and stored in a suitable container, such as a beaker. To minimize dehydration effects, the shrimp were covered with moist cheesecloth. Periodically each batch was examined organoleptically from which shrimp were removed for analysis. The tests used included the determination of VRS, TVN and TMN (described by Farber and Ferro, 1956) and of total aerobic bacterial numbers (described by Lerke and Farber, 1956). The content of VRS is expressed as microequivalents of reduction per 5 ml. of press juice; that of TVN and TMN as milligrams of nitrogen per 100 ml. of press juice; and the total aerobic bacterial numbers as logarithms of the number of organisms per ml. of press juice. Photographs of a single unit and of a multi-unit VRS apparatus are shown in Figures 1 and 2.

The results obtained are presented in Tables 1 to 6. The course of spoilage at 42°F. (in a household mechanical refrigerator) and at 30°F. of raw beheaded unpeeled shrimp is shown in Table 1, where the contents of VRS, TVN and TMN were measured after increasing storage intervals. Even though the TVN and TMN values showed some increase in the early stages of spoilage, the VRS values showed greater and more definite increases at the same spoilage levels. A sharper differentiation of early incipient spoilage is possible with the VRS determination than with the TVN method, which was better than the TMN determination. Shrimp spoilage at two higher temperatures, 76°F. (24.4°C.) and 82°F. (27.7°C.), is exemplified by the data of Tables 2 and 3. Here the values for VRS and log of bacterial numbers are shown after

TABLE 1

CHEMICAL CHANGES IN BEHEADED RAW SHRIMP DURING SPOILAGE AT VARIOUS TEMPERATURES

Days Stored	Storage Temperature °F					
	30			42		
	VRS	TVN	TMN	VRS	TVN	TMN
0	7.1	1.1	0	7.1	1.1	0
2	5.1	1.5	0	3.5	1.5	0
3	5.7	1.1	0	7.5	1.5	0
4	-	-	0	4.9	2.7	0
5	4.3	1.1	0	8.0	3.8	0
6	7.5	1.1	0	18.7[1]	8.3	0.7
7	9.8	3.0	0	35.9[2]	7.5	2.7
8	8.0	1.9	0			
10	16.1[1]	3.7	0.65			
11	23.0[2]	4.5	0.65			
12	35.0	6.8	1.5			
13	43.0	11.4	2.7			

VRS—Volatile Reducing Substances, as microequivalents per 5ml. press juice
TVN—Total Volatile Nitrogen } as milligrams nitrogen per 100ml. press juice
TMN—Trimethylamine Nitrogen }

1. Judged organoleptically to be at incipient stage of spoilage
2. Judged organoleptically to be definitely spoiled

TABLE 2

CHANGES IN VRS AND BACTERIAL NUMBERS IN RAW BEHEADED SHRIMP STORED AT 76°F. (24.4°C.) AFTER A 15 MINUTE DIP IN 5% SODIUM CHLORIDE SOLUTION WITH AND WITHOUT 15 P.P.M. CHLORTETRACYCLINE

Hours Stored	V. R. S.		Log Bacterial Numbers	
	Control	Treated	Control	Treated
0	6.5	6.5	4.65	4.65
18	9.5	1.0	6.80	5.80
22	13.0	6.5	7.85	6.30
26	44.0[1]	14.5	8.60	7.65
30		38.5[1]		8.50

1. Judged organoleptically to be definitely spoiled

increasing storage intervals. The progressive increase in VRS and bacterial numbers is evident. In addition, the definite though short-lived prolongation of the keeping quality by the CTC dip at the relatively high temperature is also noteworthy, as shown by the VRS and bacterial contents, as well as by the organoleptic judgment. A spoilage picture for peeled and unpeeled raw beheaded shrimp at another relatively high ambient temperature is shown by the data of Table 3. Here again the progressive increase in VRS values and bacterial numbers with storage time is clearly evident. In addition, the effect of peeling the shrimp on their keeping quality is also to be noted, as well as that of the CTC on the peeled and unpeeled shrimp. This prolongation of the storage time by the CTC and by peeling becomes much more marked

TABLE 3

CHANGES IN VRS AND BACTERIAL NUMBERS IN RAW BEHEADED SHRIMP STORED AT 82°F. (27.7°C), AFTER A 15 MINUTE DIP IN 5% SODIUM CHLORIDE SOLUTION WITH AND WITHOUT 15 P.P.M. CHLORTETRACYCLINE

Hours	V.R.S.				Log. Bacterial Numbers			
	Control		Treated		Control		Treated	
Stored	Whole	Peeled	Whole	Peeled	Whole	Peeled	Whole	Peeled
0	6.0	6.0	6.0	6.0	6.05	6.05	6.05	6.05
9	9.0	2.8	3.8	1.0	8.15	6.95	6.85	5.80
12	17.3[1]	10.3	9.5	4.5	8.20	7.65	7.30	6.60
13	21.0[1]	—	—	—	8.25	—	—	—
14	35.0[2]	14.5	18.5[1]	6.0	8.35	7.90	8.05	6.95
16	—	20.5[1]	33.5[2]	5.5	—	7.95	8.10	7.15
18	—	42.0[2]	—	7.0	—	8.00	—	7.65
19.5	—	—	—	14.0	—	—	—	7.82
21	—	—	—	35.0[2]	—	—	—	8.05

1. Judged organoleptically to be at incipient spoilage state
2. Judged organoleptically to be definitely spoiled

as the temperature is lowered, as shown in subsequent tables.

From the data presented above and from many other similar ones, it became evident that, under our experimental conditions, shrimp with a VRS content of 15 microequivalents per 5 ml. of press juice still could be considered passable for use, but were approaching the zone of early spoilage sometimes called incipient spoilage. At this stage the really fresh shrimp odors were weaker or even hardly noticeable and were accompanied to varying degrees by other odor components associated with deteriorative changes. Accordingly, in order to establish some objective criterion of the condition of shrimp treated in various ways, a VRS value of 15 microequivalents per 5 ml. of press juice was arbitrarily adopted. It was realized that this value represented a minimum value, since shrimp were still considered edible at this time and still had some storage life before any detectable off or abnormal or undesirable odors could be expected to develop. Nevertheless, it was felt that this was a reasonable

TABLE 4

EFFECT OF CHLORTETRACYCLINE (CTC) CONCENTRATION ON THE STORAGE LIFE OF BEHEADED RAW SHRIMP AT 42°F. (5.5°C.)

CTC Conc.	Days to attain a VRS Value of 15 microeq'ts per 5 ml. juice	
P. P. M.	Whole	Peeled
0	3.8	4.1
2	—	4.5
5	5.1	5.6
15	5.8	13.4
25	5.5	12.2
50	6.8	
100	7.3	

Shrimp dipped 5 minutes at each concentration dissolved in 5% NaCl solution. Averages of 3 to 5 experiments

objective criterion for use in judging the effectiveness of the diverse treatments which the shrimp were given.

Using this criterion of the condition of shrimp, the effectiveness of a number of CTC concentrations was studied with the results shown in Table 4. It is evident that beyond 15 p.p.m. no marked or significant increase in keeping time was obtained, particularly for the peeled shrimp. From practical considerations as well, including cost and uptake, it was felt that a concentration of 15 p.p.m. of CTC was a useful level with which to continue further experimentation.

Some data on the influence of length of dipping time in a 15 p.p.m. CTC in 5 per cent sodium chloride solution are shown in Table 5. A 5-minute dip

TABLE 5

EFFECT OF DIPPING TIME IN 15 P.P.M. CHLORTETRACYCLINE SOLUTION IN 5% NaCl SOLUTION ON STORAGE LIFE OF BEHEADED SHRIMP AT 42°F (5.5°C.)

Dipping Time Minutes	Days to Attain 15 Microeq'ts VRS
5	6.1*
15	6.0*
60	5.7*

*average of 3 experiments

was apparently adequate and no enhancement in effect was found with longer immersion. In fact, longer exposures apparently were less effective than the shorter times. This effect has also been noted by others, such as Camber (1955).

Peeled and unpeeled raw beheaded shrimp were dipped for five minutes in a 15 p.p.m. CTC solution in 5 per cent sodium chloride and then stored until spoiled at various temperatures. The results are given in Table 6. The increase in effectiveness of the CTC with a lowering of the temperature is quite marked. This is particularly evident for the treated samples, and even more outstanding for the peeled shrimp. To obtain the greatest benefit from a CTC treatment, temperatures around 40°F. or lower should be used.

From the data presented above a number of observations can be made. The

TABLE 6

EFFECT OF A 5 MINUTE 15 P.P.M. CHLORTETRACYCLINE IN 5% NaCl SOLUTION DIP ON THE STORAGE LIFE OF RAW BEHEADED SHRIMP AT VARIOUS TEMPERATURES

Storage Temp. °F.	Storage Temp. °C.	Days to Attain a VRS Value of 15 microeq'ts per 5 ml. juice			
		Untreated		Treated	
		Whole	Peeled	Whole	Peeled
82	27.7	0.46	0.56	0.59	0.82
76	24.4	0.94	—	1.09	—
58	14.4	1.64	1.77	1.85	2.60
53	11.7	2.0	—	2.8	—
48	8.6	2.1	—	3.8	—
42	5.5	3.8	4.1	6.1	13.4
30	1.2	9.8	10.0	16.0	37.4

VRS procedure offers a useful means to evaluate the condition of shrimp and closely parallels the organoleptic judgment. Using the VRS technic an arbitrary quality standard for shrimp held under the present experimental conditions has been adopted, based on the VRS value of 15 microequivalents per 5 ml. of press juice. Using this VRS value, the effect of various treatments could be quantitatively evaluated. The usefulness of the total volatile and trimethylamine nitrogen contents is very much less than that of the VRS content as an index of the condition of shrimp. This has also been pointed out by Fieger (1953).

A five minute dipping or immersion time and a CTC concentration of 15 p.p.m. appear to be the most useful and practical conditions to obtain a significant prolongation of the keeping quality of either unpeeled or peeled shrimp. Peeling the shrimp markedly enhances the efficacy of the CTC treatment in extending the storage time of the shrimp.

Summarizing the data presented in this report, the following points can be made:

1. The volatile reducing substances (VRS) procedure offers a useful means for the chemical evaluation of the state of freshness of shrimp.
2. A dipping or immersion time of five minutes appears to be adequate.
3. A concentration of chlortetracycline of 15 p.p.m. is adequate to obtain a significant prolongation of the keeping time of shrimp.
4. The efficacy of chlortetracycline to prolong the storage life of shrimp is influenced by the storage temperature. For significant effects storage temperatures of 40°F. or lower should be used.
5. Peeled raw beheaded shrimp are benefited by the chlortetracycline immersion to a greater extent than the unpeeled shrimp. The keeping quality has been increased more than twice for the peeled compared to that for the unpeeled raw beheaded shrimp.

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The Effect of the Antibiotic Chlortetracycline On Shrimp Freshness

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Abstract

Control of bacterial spoilage in fish fillets, eviscerated, or round fish by the use of the antibiotic chlortetracycline has been demonstrated by Tarr and others. An investigation at The Marine Laboratory of the University of Miami was concerned with development of methods of application of CTC under commercial conditions to retard bacterial spoilage in pink shrimp, *Penaeus duorarum*. Results from these tests show that at levels of no less than 30 ppm (applied as a dip for five minutes) and five ppm in ice, the period preceding the rapid rise in bacterial growth can be extended by as much as seven days. Organoleptic tests showed that odor scores were higher for the treated samples than for the non-treated samples. Flavor was improved by all concentrations of CTC tested when applied as a dip. No differences in flavor were detected by the panel when shrimp were stored in CTC ices. The formation of black spot in shrimp seems to be accelerated in the presence of calcium and other bivalent ions and it was necessary to use a monovalent ion, such as potassium, in the preparation of ices containing the antibiotic. Cooked shrimp showed a considerable reduction in the residual content of CTC compared with uncooked samples, and generally less than one microgram (30 ppm CTC dip) after the ninth to tenth day of iced storage. Shrimp stored in CTC ices generally showed less than 0.15 micrograms of residual CTC during the ninth to twelfth storage day.

International Law of Fisheries

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In international law the question of fisheries did not arise as an independent problem but rather is found imbedded in a much broader and much more complex set of questions. This set of questions arises in an attempt to solve the problem of how far the powers of a nation reach into the seas. It is not difficult to establish the limits of powers on land; there they follow well defined landmarks dividing adjoining territories. Equally simple in its application is the present rule as to how high the control of a country shall reach into the space. However, the question of the extent of national sovereignty or of some limited national controls over the sea remains a controversial one, and this is where the question of fisheries comes in.

(I)

Between the coast which is under the complete sovereignty of a particular country and the area of the high seas which is under the sovereignty of none, various transitional areas have gradually developed. Starting from the coastal waters where the state exercises all, or almost all, powers vested in a sovereign nation, i.e. legislative, judicial and administrative, to the complete exclusion of all other nations, these powers taper off step by step through intermediate areas where only a limited amount of controls may be exercised by the coastal state, reaching finally the vanishing point in the area of high seas free to all nations.

Simplified, these subsequent areas of progressively decreasing powers may be illustrated by the following scheme. Immediately along the coast there may be a strip of the sea called "internal waters," which include the waters in bays, harbors or inside base lines.[1] Beyond this strip, or where there is none, directly from the coast, a maritime zone is situated, traditionally three miles wide, called the "territorial sea" (also marginal or littoral sea, or even tide-lands).[2] In regard to both of these areas, the internal as well as the territorial sea, it is generally recognized that the coastal state is entitled to exercise all the powers vested in a sovereign nation. Naturally, such exercise may be limited by treaties or the generally accepted rules of international law, as, for example, the right of innocent passage by foreign vessels. Consequently, all resources within these areas, including the sea bed, its subsoil and the superjacent waters (and all the fish therein) are within the exclusive control of the coastal state to the complete exclusion of any other power or its nationals.

As mentioned before, the traditional width of the territorial waters is three miles. Recently this rule has been abandoned by certain expansionist countries extending by unilateral acts what they call their "national territory" beyond the traditional three miles into the high seas.[3] Some have placed this extension as far as 200 miles from their coast.[4] This would mean that vast areas of the high seas would come under the exclusive control of these coastal states which would, in turn, entitle them to enact legislation therein effective, to exercise judicial powers, to tax or to administer (police) these areas in any way they please. To fishing this would mean the disappearance of the principle of freedom of fishing which the present regime of the high seas has always embodied. That traditional freedom would be replaced by one-sided controls

of the coastal state. This state would then have the freedom to license, fine, tax, pass discriminatory legislation and what have you.

These attempts have been immediately and strongly opposed by all the important maritime powers. The United States, for one, has lodged with the respective governments strong protests, pointing out that such unilateral acts are "at variance with the generally accepted rules of international law" and expressly reserving in regard to fishing "the rights and interests of the United States."[5]

Beyond these two zones, the internal and territorial waters, another area is now recognized. This new third zone found its origin in the Continental Shelf.[6] The Continental Shelf is that part of the sea bed and its subsoil beyond the limits of the territorial sea and still within such distance from the coast that exploitation is feasible. Such exploitation has extended the shelf to the point of maximum 100 fathoms in depth. Motivated by their interest in natural resources (oil, coal, minerals, etc.) and, to a smaller degree, by considerations of defense, adjacent countries therein claim, by means of unilateral declarations, what is generally termed "control and jurisdiction," but which amounts for all practical purposes to full sovereignty. Such claims to the shelf, generally acquiesced in by other countries, exclude, by definition, all other countries and their nationals from any control or activities in these submarine areas. However, the regime of the superjacent sea is unaffected and remains that of the high seas; consequently, navigation and fishing are free to all nations. This is the position taken by this country[7] in accordance with international law.

The expansionist movement is noticeable in this area as well. Some countries, grossly misreading[8] the Truman Proclamation[9] and, using such version as a precedent, extended claims from the continental shelf not only to the superjacent sea, the "epicontinental sea," but also to include full sovereignty beyond this area far into the high seas. Into this extension at some rough figure, let us say 200 miles, was included, along with the sea itself, the sea bed, its subsoil and even the airspace.[10]

However, this is not the end of the story. From the outer limits of the territorial sea an additional zone is situated, called the contiguous sea. It must be borne in mind, however, that this zone may cover different areas of the sea according to its line of origin. For countries adhering to the traditional three mile zone, the contiguous sea starts there. Countries that have pushed their "national territory" deep into the high seas, it will start at six, nine, twelve or even 200 miles. Regardless of the point to which the "territory" has been expanded, it is generally recognized that beyond this line the regime of the high seas prevails. And even here, coastal states claim certain additional controls.[11] For countries adhering to the traditional three mile zone such controls are reasonable. This country, for example, has established two kinds of areas beyond its territorial waters: one, as far as nine miles beyond the three mile zone, called "customs waters"[12] where custom controls may be exercised; and the other, the "conservation zones" provided by the Truman Proclamation.[13] Within this latter zone, the United States claims, in accordance with international law, the right to control fishing of its own nationals;[14] on the other hand, in areas where nationals of other countries are engaged in fishing as well, conservation measures may be established only by mutual agreement of the countries concerned. Accordingly, the Proclamation recognized "the right of any State to establish conservation zones off its shores in accordance with the above principles . . . provided that corresponding recog-

nition is given to any fishing interests of nationals of the United States . . . in such areas." In spite of such measures, these areas shall remain under the regime of the high seas, and "the right to their free and unimpeded navigation . . . (is) in no way thus affected."

It is, however, surprising to find that countries claiming the 200 mile territorial waters do not stop there but claim additional controls, even unilateral, over fishing in the contiguous sea already remote from their shores, invoking primarily biological arguments with particular emphasis on interdependence and migration of fish.[15] Such attempts could, if not met with common sense, degenerate into some kind of nationality of the fish population, probably according to their habitual domicile in some part of the expanded "national territory." This remark, of course, is not intended to minimize the importance of bona fide conservation measures which, if effectively handled and not only claimed, are in the interest not only of the coastal states but of all other maritime powers with fishing interests in these areas.

(II)

The first part of our discussion was intended to show how, under international law, fisheries may be subject to partial or complete control by the coastal states or how they may be free to all.[16] It is well known, however, that some important fisheries within the area of the high seas, as well as some within territorial waters, are controlled by "international agreements."[17] In regard to the former, conservation agreements can by their nature bind only the signatory countries and their nationals. The outsiders, non-signatories, are not controlled. This may be remedied by adoption of the methods suggested by the International Law Commission of the United Nations.[18]

It may be stated that within the Western Hemisphere fishery problems are playing an increasingly important role.[19] Countries that expanded their "national territory" far into the high seas, particularly Chile, Ecuador and Peru, joined forces in order to secure these attempts. At their first conference in Santiago (1952) the CEP countries made the 200 mile zone their common cause and reiterated their position that this area of the high seas, including the sea bed and its subsoil, is "subject to the exclusive sovereignty" of these countries, only "innocent and inoffensive passage"[20] excepted. Later, in Lima (1954), the same countries closed their ranks even tighter and decided on concerted action to put teeth into their claims. This country, constantly opposing such attempts, tried to reach a mutually acceptable solution. As a result a conference was held with the CEP countries in Santiago (1955) without success.[21]

Another way was still available to work for a solution, through the Organization of American States. Its Juridical Council was to prepare materials for a specialized conference of the Organization. The Council met in Mexico (1955) where, in a rather unusual way and far beyond its authority, it adopted, against the vote of the United States, a document called the Principles of Mexico, following the views of the expansionist countries as the "expression of the juridical conscience of the Continent."[22] It is not surprising to find that the Specialized Conference of the Organization (Ciudad Trujillo, 1956)[23] was unable, and probably unwilling, to consider these Principles as a workable basis for its deliberations. Instead, it adopted a Declaration containing a realistic inventory of agreements and disagreements and suggested that the Organization continue its efforts to reach an adequate solution.

This is where things stand now.

(III)

The question of control over the sea and its riches has attracted the attention of universal organizations as well. The League of Nations considered the problem (1930).[24] After 1945, these efforts were continued by the United Nations through its International Law Commission. In addition, the Food and Agricultural Organization, one of the specialized agencies of the U.N., took up the question of fishery conservation and at the Rome conference (1955) adopted a report accompanied by general conclusions.[25]

The International Law Commission, on the other hand, in charge of surveying the whole field of international law with a view to selecting topics for codification, chose as one of them the law of the sea. It is true, of course, that this Commission, like the United Nations, has no power to create law binding upon member states. Nevertheless, findings of the Commission, as to what the law is, have the inherent weight of an authoritative restatement. Moreover, the Commission may advance new solutions which, if adopted by member states, will greatly influence future developments in the law of the sea.

The Commission has, on the basis of the first draft (1955)[26] prepared a second and final draft (1956),[27] and submitted it to the General Assembly of the United Nations now (1957) in session in New York.

Without going into the legal details of the draft, we may well summarize here the most important findings of the Commission having direct bearing on fisheries. First, we see that the Commission, faced with divergent positions on the width of territorial waters, was unable to do anything but state that "international practice is not uniform as regards the delimitation of the territorial sea"; however, the Commission felt that it is in violation of international law to extend the regime of territorial waters beyond a maximum of twelve miles which, incidentally, clearly shows that claims up to 200 miles are untenable under international law.[28] In addition, the Commission stated that within the area from the minimum line of three miles and the maximum line of twelve miles countries take different positions. In the words of the draft, "many states have fixed a breadth greater than three miles and, on the other hand, states do not recognize such a breadth when that of their own territorial waters is less" (Art. 3). There can be no doubt, though, that according to the Commission the high seas begin at least at the twelve mile line off the coast and, consequently, freedom of fishing is guaranteed there under international law (Art. 27,2 and 49). Additional provisions deal with conservation of living resources of the high seas (Art. 50-60) which plan to give the coastal states a say regardless of the fact their nationals are not engaged in fishing within the contiguous sea while other countries will only have their interests represented provided their nationals fish there (Art. 52).

It may be added that a modified definition of the continental shelf as one depending upon the feasibility of exploitation regardless of the depth did not, of course, affect the Commission's position on fishing in the epicontinental sea. The Commission unequivocally found that "the rights of the coastal states do not affect the legal status of the superjacent waters as high seas, or that of the airspace above these waters" (Art. 69). This means that not only must the freedom of navigation remain unimpaired but that the freedom of fishing there must also remain unimpaired.[29]

During the greater part of December 1956, this draft was discussed by the Sixth Committee of the General Assembly. In its final resolution[30] submitted

to the Assembly, the Committee calls for an international conference in Rome (1958) to "examine the law of the sea, taking into consideration not only the legal, but also the technical, biological, economic and political aspects of the problem and to embody the results of this work in one or more international conventions or such other instruments as it may deem appropriate," with the Commission's draft "as the basis for its consideration of the various problems involved in the development and codification of the law of the sea . . ."

1. Lines along deeply indented coasts with islands in immediate vicinity, running along the outer points but not departing from the general direction of the coast to include waters closely connected with the adjacent land. Leading case: Anglo-Norwegian Fisheries Case (1951). Evensen, The Anglo-Norwegian Fisheries Case and Its Consequences, 46 Am.J.Int'l L. 609 (1952); also 65 Harv.L.Rev. 1453 (1952) and 4 Stan. L.Rev. 546 (1952).
2. This rule is maintained by the United States. For documentation, 1 Wharton, A Digest of International Law 71, 100 (1887); Moore, A Digest of International Law 698, 702 (1906), and Hackworth, Digest of International Law 623 (1940). Hyde, 1 International Law . . . 451 (1947); Jessup, The Law of Territorial Waters and Maritime Jurisdiction (1927); Batty, The Three-Mile Limit, 22 Am.J.Int'l L. 503 (1928); Boggs, Delimitation of Seawards Areas under National Jurisdiction, 45 Am.J.Int'l L. 240 (1953); Dickinson, Jurisdiction at the Maritime Frontier, 40 Harv.L.Rev. 1 (1926); Frazer, The Extent and Delimitation of Territorial Waters, 11 Corn.L.Q. 455 (1926); Price, Sovereignty and Ownership of the Marginal Sea and Their Relation to Problems of the Continental Shelf, 3 Baylor L.Rev. 243 (1951).

   In regard to fisheries, Riesenfeld, Protection of Coastal Fisheries under International Law (1942); Allen, Legal Limits of Coastal Fishery Protection, 21 Wash.L.Rev. 1 (1946).

   Note also reports on territorial waters by Baxter and by Whiteman in the Proceedings of the American Society of International Law, 1956, 116 and 125 (1956).

   In regard to the Gulf of Mexico, adjacent states of the Union claim at least three marine leagues, i.e. nine miles, as their territorial waters, Ireland, Marginal Seas Around the States, 2 La.L.Rev. 252 (1940). So does Florida (Art. 1 of the Constitution, 1868); for background, The Abby Dodge, 223 U.S. 116 (1911), Pope v. Blanton, 10 F.Supp. 18 (1935) and Skiriotes v. State, 197 So. 736 (1940) aff'd on other grounds under 313 U.S. 69 (1941), all involving sponging. In regard to the Tortugas and adjacent shrimp grounds as Florida territory, see Atty. Gen. Rep. 1949/50 at 413.

   For the purposes of the Submerged Lands Act (1953, 67 Stat. 29, 43 USC 1301) the term "boundaries of a State" included in the Gulf of Mexico boundaries as they existed at the time such State became a member of the Union, or as theretofore approved by Congress, or as extended or confirmed pursuant to Sec. 1301 of Tit. 32 USC, but "in no event shall the term boundaries or the term lands beneath the navigable waters be interpreted as extending more than three geographic miles into the Atlantic Ocean or the Pacific Ocean, or more than three marine leagues into the Gulf of Mexico."
3. For documentation, 1 United Nations, Laws and Regulations on the Regime of the High Seas (1951). For a list of claims as of 1930, 1 Hackworth, op. cit. 628. Phister, Regime of the High Seas, Proceedings of the American Society of International Law, 1956, 136 (1956).

   In 1935 Mexico extended its territorial waters to nine miles off coasts; this country notified reservations, 1 Hackworth, op. cit. 693, but Mexico countered by invoking Art. V of the 1848 treaty, which argument was declined, 1 Hackworth, op. cit. 640. Difficulties date back to 1906, 1 Hackworth, op. cit. 657. For the British position, 1 McNair, International Law Opinions 351 (1956).
4. For example, Peru, Chile, Ecuador.
5. Note to Peru (1948, text in 1 United Nations, Laws and Regulations . . . 17), Chile (1948, ibid. 7) and El Salvador (1950, ibid. 300). Answer in Memoria del Ministerio de Relaciones Exteriores (Peru) 180 (1955).
6. Mouton, The Continental Shelf (1952). Benton, The Continental Shelf: International Aspects, 6 S.W. L.J. 488 (1952); Bingham, The Continental Shelf and the Marginal Belt, 40 Am.J.Int'l L. 173 (1946), and Juridical Status of the Continental Shelf, 26 So.Cal.L.Rev. 4 (1952); Borchard, Resources of the Continental Shelf, 40 Am.J.Int'l L. 53 (1936); Holland, The Juridical Status of the Continental Shelf, 30 Texas L.Rev. 587 (1952); Hounshell, The Continental Shelf, 5 J.Publ.L. 343 (1956); Lauterpacht,

Sovereignty over Submarine Areas, 27 Brit. YB. Int'l L., 1950, 376 (1951); Young, The Legal Status of Submarine Areas beneath the High Seas, 45 Am.J.Int'l L. 225 (1951).

7. According to the Outer Continental Shelf Lands Act (1953, 67 Stat. 462, 43 USC 1331) "outer continental shelf means all the submerged lands lying seaward and outside of the area of lands beneath navigable waters as defined in Sec. 1301 of this title (see note 2 above), and of which the subsoil and seabed appertain to the United States and are subject to its jurisdiction and control." Such powers, however, must not be "construed in such a way that the character as high seas of the waters above the outer continental shelf and the right of navigation and fishing shall not be affected." The Presidential Proclamation establishing such area, 59 Stat. 884.

   Christopher, The Outer Continental Shelf Lands Act: Key to a New Frontier, 6 Stan.L.Rev. 23 (1953).
8. For example, Memoria del Ministerio de Relaciones Exteriores (Chile), 1947, at 203.
9. See below, note 13.
10. For a penetrating criticism, Kunz, Continental Shelf and International Law, 50 Am.J. Int'l L. 828 (1956). Boggs, National Claims in Adjacent Seas, 16 Geo.Rev. 185 (1951).

    This country claims controls to identify aircraft in the air beyond its territorial waters (ADIZ), 14 CFR 620.1 (b) (1955).
11. Bishop, Exercise of Jurisdiction for Special Purposes in High Seas Beyond Outer Limits of Territorial Waters, 99 (2) Congr. Rec., 83rd Congr. 1st Sess. 2493; see also at 2491.
12. 19 USC 1401 (m) (1955); beyond this area a customs enforcement area may be declared by Presidential Proclamation (ibid., Sec. 1701); however, no more than 50 miles beyond customs waters.
13. 1945, 59 Stat. 885. Selak, Recent Developments in High Seas Fisheries under the Presidential Proclamation of 1945, 44 Am.J.Int'l L. 670 (1950).
14. 16 USC 781 provides to be unlawful "for any citizen of the United States, or person owing duty of obedience to the laws of the United States, or any boat or vessel of the United States, or person belonging to or on such boat or vessel, to catch . . . in the Gulf of Mexico or in the Straits of Florida outside of State territorial limits, any commercial sponges measuring . . ."

    For Florida statutes regulating taking sponges in her own territorial waters in the Gulf of Mexico, Fla. Stat. 370.17 (2) (1955). For cases, note 2 above.
15. Garaicoa, The Continental Shelf and the Extension of Territorial Waters, 10 Miami L.Q. 490 (1956); Aramburu, Character and Scope of the Rights Declared and Practiced over the Continental Sea and Shelf, 47 Am.J.Int'l L. 120 (1953).
16. Statements on the United States position: Chapman, United States Policy in High Seas Fisheries, 20 Dep't State Bull. 67 (1949); Phleger, Recent Developments Affecting the Regime of the High Seas, 32 Dep't State Bull. 934 (1955); Greenbaum, Proposed United Nations Conference on the Law of the Sea, 36 Dep't State Bull. 60 (1957).
17. Bilateral conventions are in force in relation to Canada (sockeye salmon, 1930, 50 Stat. 1355 with additional protocol 1956, 36 Dep't State Bull. 76, 1957; ascent of salmon, 1944, 59 Stat, 1614; halibut, 1950, 1 UST 536, 1953, 5 UST 75) and Mexico (tuna, 1949, 1 UST 513). Multilateral conventions on seals (1952, 3 UST 3896), whaling (1931, 49 Stat. 3079; 1946, 62 Stat. 1716), fishing in the North West Pacific (1949, 1 UST 471), North Pacific (1952, 4 UST 380) and one on the Indo-Pacific Fisheries Council (1948, 62 Stat. 3711). Leonard, International Regulation of Fisheries (1944); Daggett, The Regulation of Maritime Fisheries by Treaty, 28 Am.J.Int'l L. 104 (1934).
18. Solution to be reached by a combined method of compulsory negotiation and arbitration. Where nationals of more countries are engaged in fishing, such states must engage in negotiations; if negotiations should fail, the dispute will be settled by arbitration (Art. 52). Latecomers have to accept the status quo, though their states may demand a renegotiation of the preexisting agreement; in case of failure, issues must be arbitrated (Art. 53). Coastal states are granted "special interests" in all cases (Art. 54); they even may adopt unilateral conservation measures if negotiations with countries with fishing interests there should have failed, provided such measures are warranted by enumerated conditions and, in addition, there is no discrimination against other (the draft has the inappropriate term "foreign") fishermen (Art. 55).
19. Bayitch, International Fishery Problems in the Western Hemisphere, 10 Miami L.Q. 499 (1956); Young, Pan American Discussions on Offshore Claims, 50 Am.J.Int'l L. 909 (1956).
20. Selak, Fishing Vessels and the Principle of Innocent Passage, 48 Am.J.Int'l L. 627 (1954).
21. U.S. Department of State, Santiago Negotiations on Fishery Conservation Problems

(1955); also 33 Dep't State Bull. 1025 (1955).
22. 34 Dep't State Bull. 296 (1956).
23. 34 Dep't State Bull. 894 (1956).
24. Reeves, The Codification of the Law of Territorial Waters, 24 Am.J.Int'l L. 486 (1930); for documentation, ibid. Supp. 25 seq
25. United Nations, Report of the International Technical Conference on the Conservation of Living Resources of the Sea (1955); and Papers Presented at the . . . (1956).
26. Bishop, International Law Commission Draft Articles on Fisheries, 50 Am.J.Int'l L. 627 (1956); for the United States position, ibid. at 1037.
27. United Nations, Yearbook of the International Law Commission 1956 (1956); and Report of the International Law Commission Covering the Work of its Eighth Session (1956); for the United States position, see Greenbaum, 36 Dep't State Bull. 60 (1957).
28. Brittin, Art. 3 Regime of the Territorial Sea, 50 Am.J.Int'l L. 934 (1956).
29. Kwang Lim Koh, The Continental Shelf and the International Law Commission, 35 B.U.L.Rev. 522 (1955).
30. Text in 36 Dep't State Bull. 61 (1957).

DISCUSSION

Shrimp Session

Discussion Leader: LAWRENCE W. STRASBURGER
Discussion Panel: MARY SCHULMAN, A. J. HARRIS, DONALD H. MCKEE, BERLIN FELTON

Aims and Progress of Gulf Fishery Investigations' Shrimp Research

THOMAS J. COSTELLO

Q. Strasburger: In your statement you made a remark with regard to the way the white shrimp enter the estuaries. Can you elaborate on this?

A. Costello: Probably the biggest factor is that the white shrimp larvae and post larvae are completely at the mercy of currents. Where the currents are favorable a large group enters through the passes. At Galveston we have about four years of data of abundance of small shrimp at East Pay Lagoon, and we find that the entry of the white shrimp depends largely upon the direction of the currents. White shrimp larvae and post larvae enter in large numbers perhaps for a day and a half and then for a week or two they will almost disappear.

Q. McKee: Would the method of staining or tagging shrimp work equally well on brown and pink shrimp?

A. Costello: The stains are usable on all species of shrimp, as far as we know, and I suspect that they are probably usable on other marine decapods as well. There are three colors of stains, red, green and blue. All are almost equally distinct, although I think that the blue is the best.

Q. McKee: How long will these stains last?

A. Costello: At least three months, and perhaps longer.

Q. Felton: Will this stain affect the quality of the shrimp?

A. Costello: No. They all have the U. S. Food and Drug Administration clearance.

Q. McConnell: In many areas in Louisiana the salinity has gone up in the last few years. We have also had a distinct reduction in white shrimp, particularly in the east side of the Mississippi River. Are these related?

A. Costello: Mr. Chin in our laboratory has done a lot of work with the salinity tolerance of white shrimp. The adults can stand very abrupt changes of salinity. I doubt very seriously if salinity alone could have any dire effect on the white shrimp.

Q. McConnell: We have always found in Louisiana that every time the Mississippi River is high we have a very high production of white shrimp. There has been no high rivers in Louisiana for many years. Is there anything that you have done that might lead you to see any connection here?

A. Costello: No, but an ecologist would say that to make a body of water more productive, flood the lowlands around it.

Q. Gunn: In 1954 at a special meeting of the Gulf States Marine Fisheries Commission in Biloxi, a program was developed for research on shrimp. Some of that program is being pursued to a rather full extent at the present time. One aspect has to do with establishing statistics, the other is sampling of the catch for size and species composition. The development of marking techniques seems to be progressing very well. When do you think that we will be able to get the states started on a marking program?

A. Costello: Any laboratory that wished to tag shrimp should go through the Commission to avoid duplication of stains.

Gunn (Comment): One reason I am anxious to bring this up here is that we are going to need cooperation of all the shrimp operators in collecting marked shrimp.

Q. Gunn: One item of the research project calls for an ecological study of the nursery grounds.
Is this ecological survey at the present time being confined to Galveston Bay? It was originally planned that this study would be carried on in all of the states. It was estimated that it would cost $190,000 for the first year and $90,000 per year after the first year. I haven't seen any such appropriation in the budgets. It would be interesting to know what plans have been made to pursue this ecological study, which was supposed to take five years.

A. Costello: To date we have four study areas. They are not in Galveston Bay exactly, but they are in that general area. Albert Collier is assigned to report on the data that he has accumulated for the past five years and thereafter he will head up a new research group which will deal with coastal ecology.

Weekly Shrimp Sampling in Apalachicola Bay, with Biological Notes and Regulatory Applications

ROBERT M. INGLE

Q. Strasburger: Is not the method of regulating shrimp fishing, that you spoke of this morning, subject to political pressures?

A. Ingle: Yes, it is subject to political pressure and if the political climate is such that it will yield to that pressure, I imagine the system will not work. In Florida it is favorable right now. Neither state or national laws can impose any regulations on the nationals of any other country that fish Tortugas. Florida has not attempted any extension of this rule, which covers only nine counties in the state. Nationals of one other country, Cuba, fish in that area and proper discussions have already begun in order to promote an agreement with Cuba to regulate the nationals of our two countries.

Mesh Size Regulations as a Possible Method of Managing the Tortugas Shrimp Fishery

JAMES D. REGAN, C. P. IDYLL and EDWIN S. IVERSEN

Q. Bullis: Is it your opinion that there are two separate spawnings in the Tortugas grounds?

A. Iversen: The conclusions drawn so far are tentative, but it seems that this is so.

Q. Bullis: Is the size of the shrimp at capture influencing the sex ratio of shrimp? It was our observation in 1952 on the *Oregon* when we were dragging on the brown shrimp grounds that in shallow water the sex ratio was high in favor of the males, whereas offshore in the extreme ranges the population became almost all female. Have you found anything similar to this with *P. duorarum?*

A. Iversen: Yes. With the small size meshes (1¾″ in the cod end) there is approximately a 50-50 ratio. There is an unbalanced ratio with an increase in mesh size, and these nets are letting more of the small males go.

Acceptability of Frozen Shrimp

CARL R. FELLERS

and

Studies on Shrimp Spoilage and on the Effect of Chlortetracycline at Various Temperatures

LIONEL FARBER

Q. Strasburger: What was the pH of the shrimp in your studies of frozen shrimp?

A. Fellers: We did not think that pH was of any great significance.

Farber (Comment): I can substantiate that with shrimp that are really spoiled, their pH doesn't seem to have any correlation with the spoilage.

Q. McKee: Did you conduct any tests on raw shrimp meat alone and breading alone in your analyses?

A. Fellers: Yes, we have a good deal of data on such points. For the most part the quality of the shrimp didn't change very much after it was processed, because the shrimp were either good or bad when they were breaded. I don't think that the breading itself constituted anything at all to the state of decomposition of these shrimp.

Q. McKee: You mentioned that of the 24 lots you checked there was a large difference in the quality of the shrimp. That possibly could have been caused by mishandling in transit or in the plant, is that right?

A. Fellers: Yes. We have separate data for all 24 lots. We found as great a variation within a particular brand as we found among brands, so we feel that just because you buy brands that are good today, they are not necessarily good tomorrow, or the same brand is not necessarily good in another city. Some brands can consistently run better than others, but we found all the way from very bad shrimp to very good shrimp in the same brand.

Q. McKee: Was all of your work done on frozen shrimp that you picked up from the general trade?

A. Farber: Yes, we got it from brokers.

Q. McKee: Then you had no background or history on the samples. Could you really test the product under these conditions? You have no history of the catch, the length of the drag, how long it was in ice before being frozen or any of the handling data.

A. Farber: That is true, except that we could judge the quality of the material to start with. It happened that packages of frozen shrimp from two brokers were judged to be in poor condition and we did not use those. We only picked those that we judged to be good to start with. We started part way in the sequence from the time the shrimp were taken out of the water to when they reached the consumer, so that our values are probably only relative and may not be comparable to the raw material taken out of the water. Nevertheless, I think that the data show that even under our conditions, changes do take place and we can measure them.

Q. Harris: Has anything been done about studying the economics of the use of antibiotics in the event that the use of these become legal? Will the cost of shrimp be greatly affected by use of these antibiotics?

A. Miller: In Canada approval has been obtained for the use of chlortetracycline on fish but not shellfish. We are negotiating with the Food and Drug Administration for such approval in the United States. Now relative to the economics. At five ppm the cost of the chlortetracycline would add approximately $2.00 per ton to the cost of the ice.

Q. Fieger: Dr. Fellers, how long were your breaded shrimp stored

frozen? The reason I ask this is that during the freezing the bacterial counts usually decrease markedly.

A. Fellers: We do not know how long some of these shrimp have been on the market, although some companies translated their codes to us so that we know whether it has been three months or eigth months or so. As it happened, some of the samples with high counts were among those that had been frozen the longest. Now we don't know whether the count was very high in the early stages or not. We find that the kind of bacteria makes a lot of difference, and certain bacteria (Enterococci) are not killed by freezing, while other kinds are. There is a very considerable variety of bacterial species on a shrimp. There are many species that are of no significance in shrimp spoilage.

Farber: We have begun some work on the effect of individual species of bacteria in relation to spoilage. Certain species such as micrococci do not seem to have any effect, because during spoilage they actually decrease in numbers, whereas other species increase.

Experiments on the Control of Shrimp Spoilage with the use of Antibiotics

C. Isaac Camber, James Alexander and Mary Vance

Q. Strasburger: You said that in previous work done in 1953 there was a yellow discoloration noted in the shrimp when 10 ppm CTC were used. And then I gathered that in the latest work the yellow discoloration was not noted until you reached 100 ppm. Would you clarify this please?

A. Alexander: In the original work done in 1953 the shrimp were stored in an antibiotic solution over the entire storage period. The latest work involves dipping for one, five, fifteen, or thirty minutes and then storing the shrimp on non-treated ice.

Q. Costello: Did I understand you to say that you noted a better effect from a five minute dip than you did with a thirty minute dip of aureomycin? This would not seem to be logical from a microbiological point of view.

A. Alexander: Our results indicate that there is an optimum time for dipping and that a one minute dip was less effective than a five minute dip, while lengths over five minutes were less effective again.

Q. Butler: Do you consider that sufficient work has been done on a commercial scale to warrant the use of the chemical by the industry?

A. Alexander: We have not run any commercial scale tests. However, we feel that our laboratory data is practically complete and we are now about ready to enter this particular phase.

Q. Jackson: You said in effect that the International Law Commission has concluded that 10 or 12 miles might be the answer to this great problem of territorial jurisdiction. On reading the International Law Commission report—its recommendations and also the commentary—I'm certain that they took particular pains to try to express the view that in the custom and usage of international law, three miles might be regarded as the minimum of territorial limitations and that 12 miles might be the maximum. I don't think they intended to convey the impression that 12 miles should be the proper distance. Rather, it left open the determination of the proper distance between three miles and 12 miles. The report definitely indicated, however, that there was nothing in international law that could justify any claim beyond 12 miles.

Q. Anderson: What is the status of the Texas towers? Would it be possible, for example, for a foreign country to place one of these towers on the fishing ground more than 12 miles off our coast and use it as a fishing base; and if so would they be entitled to 3-12 miles around it?

A. Bayitch: Such fishing bases set within the United States Continental Shelf area would be a violation of our sovereignty; only more so if they would be within the area of continental waters belonging to a state.

TUESDAY—NOVEMBER 27

Chairman—ERNEST MITTS, *Director, Florida State Board of Conservation, Tallahassee, Florida*

A New Federal Fishing Laboratory on the Gulf

CHARLES BUTLER

Chief, Technology Section, Fish and Wildlife Service

THE CONSTRUCTION of a new Fish and Wildlife Service laboratory is under way at Pascagoula, Mississippi. This building has been designed as the operating base in the Gulf for research by the Service's Exploratory Fishing and Technological Sections. The research functions of the Exploratory Fishing and Gear Development Unit are widely known, but a word may be in order on the functions of the Technological Section, whose efforts closely supplement those of the first group. The work of the Technology Section begins with the fish resource at the point of capture and extends throughout the processing and distribution chains until the product is purchased by the consumer. It is our job to devise methods of preserving the quality of the product throughout the chain. In a sense, our work can aptly be termed "product research."

Heretofore our research program has been carried out by laboratories at Ketchikan, Alaska, Seattle, Washington, Boston, Massachusetts, and College Park, Maryland. It will readily be recognized that the Pascagoula location offers an excellent new base for several of the types of research activities we now have under way. For example, we are now conducting our southern oyster studies from the College Park Laboratory. There are manifest advantages in the close proximity of the menhaden plants to Pascagoula for part of our now well advanced and extensive fish meal and oil studies. The pressing problems requiring development of proper processing and plant sanitation programs designed to retain existing and to develop new and lucrative fresh, chilled crab markets are naturals for our new location. Certainly the higher average air and water temperatures in this area will provide maximum challenges to our projected studies of antibiotics and chemical additives to test their allegedly substantial extension of the preservation of the excellent quality inherent in sea foods as they come from the water. Pascagoula can well serve as the starting point for studies of effects of handling on the quality of iced or frozen fisheries products which are shipped to such major distant markets as New York or Chicago.

It may well be asked when all these projected developments may be expected to materialize. The answer is that already we have arranged to move one of our mobile laboratories into the Gulf to serve as a roving and probing unit pending construction and equipping of the Pascagoula Laboratory. A well qualified former resident of Mississippi will soon be seeking to pinpoint specific needs for our research attention and to get in personal contact with the seafood industry of the Gulf.

We have at every opportunity during the past few years questioned the

industry members as to the technological problems that need attention in this area. Our Pascagoula personnel, assigned to this important fisheries area, can now follow through in the development of a realistic research program if each of you will assist. The Gulf and Caribbean Fisheries Institute can well serve as the focal point of contact or clearing house for ideas, concrete problems, or suggestions that can materially facilitate development of our program. If you have occasion to be in the vicinity of the Pascagoula Laboratory make the most of the skills of our staff. By this continuing and personal interest you can aid us in keeping abreast of current needs, and help our new laboratory settle quickly into what we confidently feel will be a valuable niche in the pattern of the diverse and valuable Gulf fisheries industry.

You may expect to find among our staff a number of the accepted scientific disciplines essential to the conduct of product research. True, we do not always have men trained in every possible scientific field at each of the technological laboratories, but we do try to maintain a good balance of personnel between the several laboratories, within the limitations of available funds and with due regard for the major emphasis expected to be placed on our research in each of the several geographical areas mentioned. For example, our major emphasis at Boston is on refrigeration of fish. A close second would be the development of background information on voluntary Federal standards of quality for fillets, steaks, portion-control fisheries products and fish sticks. Required skills are training in refrigeration engineering, chemistry, microbiology and fishery products technology.

At Seattle we have stressed recently the chemistry of fish oils, raw materials analogous to petroleum or coal tar, that are potentially valuable to the chemical industry. The quality evaluation and preservation aspects allied to best use of frozen stored fisheries products is another major interest here. The types of training in the sciences required of personnel include organic chemistry, chemical engineering, fishery products technology, analytical chemistry and biochemistry.

College Park personnel have major interests in biochemistry, pharmacology, nutrition, analytical chemistry and in the chemical and mechanical engineering aspects of fisheries products research. Our Ketchikan staff, although small and geared primarily to local industry problems, still supplies talent for national use on studies of the biochemistry of fish proteins, chemical engineering aspects of fish oils, analytical chemical and microbiological aspects of fisheries products.

Thus our staff may be said to be a closely knit unit, geared to the attack on national problems of product research. We have, if you will, a split personality; a part of our combined research effort is always aimed high at fundamental studies to show (1) what fisheries material have to offer for human, animal, or chemical industry use; (2) how we can best modify or apply these unique characteristics for maximum application and value; (3) where the effort can best be placed to attain these desirable goals; and (4) why the indicated procedures can be expected to be technically and financially successful. These are the problems dealt with by our basic research units.

The other side of our personality is more immediately practical: aimed at picking the brains of other competing industries; that is to say, adapting existing knowledge for a solution of fisheries problems; or merely making more readily understood and available to interested industry members information, techniques or ideas that are known, demonstrably appropriate, and feasible of ap-

plication in the improvement of the economic status, or competitive position, of fish and fishery products. These are the problems for our applied research group.

From this general survey of our technological activities, you may have arrived at several conclusions that may warrant summary here:

(1) Our program of research is always determined by the needs of the area in which each laboratory is located.

(2) All interested industry members are solicited as consultants to guide us in our planning, to help where they can in the research, and to review our results critically.

(3) We consider that common prudence dictates the diversion of a considerable portion of our total national research effort toward the obtaining of fundamental knowledge on the "why, what, where and when" of fish and fisheries products. It is essential that these studies be made to furnish the basic building blocks that will form a firm foundation for progress in the competition of fisheries products with such other protein products as meats, the crude vegetable oils and meals, and the modified (mineral or vegetable) oils now available.

(4) The balance of our effort, and a not inconsiderable part, is devoted to the obtaining of maximum benefit from scientific knowledge *already* available. This information may have been derived either from fisheries research efforts or from the extrapolation of results in kindred research fields to fisheries problem applications. We have by no means exhausted the latter field. However, if we are to lift the fishing industry into a favorable competitive position with heavily subsidized agricultural protein products, we cannot in the future, as we now must, continue to rely solely on what can justly be termed "second-hand" knowledge. It's up to those of us who are interested in making our fisheries a factor in the nation's (and eventually the world's) economy to undertake the rough road of fundamental research. It may well be a more difficult and slow path, but you may be equally sure it will be a more rewarding one.

If you are inclined to question this premise you should examine the present status of the land-animal fats. The present market outlets for such fats include such obscure and modified forms as individually-isolated fatty acids steroids, epoxidized compounds, and allied chemical euphemisms unintelligible to many fisheries people, but none-the-less profitable items of commerce that now dominate this field. If we are to invade this area, the fundamental work, presently so admirably advanced (and for the first time in our industry's history), by the combined efforts of our dedicated Service scientists and the contract researchers (a direct result of the Saltonstall-Kennedy Act), will have to continue until we are abreast of, or preferably ahead of, the competition. This is no task to be lightly undertaken. It bids fair to be long, arduous and sometimes disappointing. Our people, however, are not only ready, but eager, to demonstrate that the confidence of the Service and of the industry, as expressed at the recent Advisory Committee meeting, is well placed in assigning to us the task of leading this carefully planned campaign to bring the fishing industry into the prominence it rightly deserves, and certainly can expect to attain.

Progress in Technological Studies on Menhaden Products Under The Saltonstall-Kennedy Program

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THIS PAPER discusses the development and progress of the fish meal and oil program largely made possible by Saltonstall-Kennedy funds. These programs, as organized and undertaken early in 1955, have important implications to food fish and to all classes of industrial fishery products, but in this paper they are discussed in terms of importance to the menhaden industry.

The research objectives deal with three categories (1) the raw material, (2) the rendering process and (3) products derived from menhaden. Investigations concerned with the raw menhaden are intended to find out about structure and composition of the fish. It is important to know how these vary with species, size, season, postmortem changes, stowage conditions, treatment with preservatives, and method of unloading from boats. In dealing with the reduction process we want to know the effects of variations in raw material and processing conditions. Also, there is interest in the nature of plant losses, possibility of modifying processing methods, introducing new equipment, and use of quality control. Fish meal, solubles and oil, the three important products of the menhaden industry, require extensive work to further our knowledge of chemical, physical and nutritional properties. We want constant improvement of quality and methods of utilization, and are anxious to develop new uses and markets.

The Saltonstall-Kennedy program on fish meal was established because of urgent requests from the fishing industry and from the Nutrition Council of the American Feed Manufacturers Association. It bears the title, "Quality Index for Fish Meal," a succinct way of stating a complex problem. Its objective is to develop a rapid method of predicting performance of fish meal in animal and poultry rations. There are two reasons why this is difficult. First, there are countless variables in fish meal manufacture resulting from differences in raw material and in processing conditions. Second, fish meal offers multiple feeding values dependent upon protein quality, vitamins, growth factors, lipids and minerals. To work out the problem it is necessary to establish the importance of variables in fish meal in correct relation to these multiple feeding values. Then, when the correct perspective has been reached it must be demonstrated in terms of simple laboratory techniques, which in turn relate to practical feeding results. This formidable problem, when attacked through well organized investigation, will extend our knowledge of our raw materials and processing methods. A quality index test for fish meal will be tremendously helpful to the fishing and feed industries.

The planning and organization of the "Quality Index" program involved numerous discussions between Government and industry people. While agreed that fish meals vary in quality, there was practically unanimous disagreement on the extent to which this occurs. Almost everyone expressed strong views regarding specific factors which lower quality of fish meal. In most instances these conjectures could not be fully supported with well founded laboratory

data. Miss Neva Karrick of the Seattle Fishery Technological Laboratory, in an effort to illuminate the problem, prepared a group of abstracts entitled, "A Literature Review on Factors that May Affect the Quality of Processed Feeds." Although useful in spotlighting some critical factors, the conclusions drawn in many of these articles could no longer be accepted as valid because the evaluation methods had become obsolete. Obviously this program would require standard samples representing excellent, medium and poor fish meals. There was little agreement as to how such fish meals could be obtained.

Because of these difficulties, the program was organized to embody collection of extensive data and use of screening tests to be carried out on samples representing commercial averages, and also those in which important variables had been introduced. Since carefully documented fish meals were needed, this job was assigned to a group of field men who supervised their preparation under full scale and pilot plant conditions. These were subjected to proximate analysis at the College Park, Boston and Seattle Technological Laboratories, and at the Alaska Fisheries Experimental Commission and the State of California Department of Agriculture. Nitrogen partition studies were undertaken at Maryland State College, and lipid investigations started at University of California. It was hoped that these data, together with a knowledge of the processing variables introduced in making the samples, could be correlated with the results of feeding tests on poultry. Here, there was a three-fold approach. Dr. Grau of the University of California, using a rapid chick assay method, determined protein quality. Dr. Bird at the University of Wisconsin undertook to investigate unknown growth factors, while Dr. Runnels, of University of Delaware, set up feeding tests intended to determine how the meals would perform in modern high efficiency feeds. Recently a project dealing with amino acid availability and vitamin content was established at Wisconsin Alumni Foundation. The work of collating data is still in progress. While manifestly impossible for the individual project leaders to interpret their data fully without knowledge of the whole picture, some of their interim findings may be of interest:

Dr. Vaughn, at Maryland State College, carried out an examination of over 70 samples which had been processed under various conditions and determined true protein, water soluble protein, bone protein and ammonia nitrogen. He recently examined these data in comparison with broiler tests on some 38 samples and found little correlation. He hastens to point out that these conclusions are not based on statistical analysis.

Dr. Brown, who is working under a collaborative agreement at the University of California Food Technology Dept., has furnished some recent information on the progress of this program. This concerns oxidative deterioration in fish and fishery products, a subject with interesting implications applying to fish meal manufacture. Their work has included studies of protein-oil reactions, protein catalysis of unsaturated fat oxidation, and use of antioxidants and synergistic mixtures in retarding oxidation of fish flesh, meals and oils. Rates of oxidation of fish meals and oils have been measured. Dr. Brown cites, as one important result, their finding that the antioxidant Santoquin is effective in reducing heating rate of oxidation and rancidity of fish meal.

Dr. Grau, of University of California, has been studying protein quality of fish meals as judged by chick feeding tests. His work has included 95 samples of menhaden fish meal and in describing his results he states that, "As is

often true in exploratory research, we did not find what we thought we might: In the first tests the wide range of fish quality and processing variables did not result in meals that were detectably variable as amino acid sources. Later studies indicated greater variability, but it has not been possible to correlate this variability with known variables in raw material or processing." He makes the further observation that the standard menhaden meal, upon storage at room temperature for eight months, deteriorated significantly, and an effort is now being made to determine if this deterioration is an isolated instance, or a general phenomenon. In addition, they now plan to investigate some possible effects of antioxidants upon fish meal quality, particularly as they may "relate to fat-protein combination and digestibility of protein content with oxidized fat."

Dr. Bird, of University of Wisconsin, has furnished some interesting comments regarding interim results of his project on growth factors. He states that this is probably "the first attempt to assay a wide range of samples of any material for the currently unknown growth factors" since such assays have usually dealt with improving the method rather than in applying it. Regarding the importance of such work, he maintains that, "Unknown growth factors are the primary selling point for fish meal used in poultry feeds." Dr. Bird reports that the best fish meals were about equal to, and the poorest about one-fourth as potent as 50 per cent condensed fish solubles. He has not been able to draw conclusions as to why this variation exists.

Dr. Runnels, of University of Delaware, is conducting the project entitled "Assay of Fish Meal for Feeding Quality in Chicks." To quote Dr. Runnels, "This project consists of feeding chicks a simplified diet calculated to be isocaloric and iso-nitrogenous, with and without fish meals. The experiments are designed to locate factors such as season of catch, holding time, location of catch, type of processing and numerous other variables that may result in biological differences. When these factors are located a more detailed study designed to demonstrate methods of improvement is carried out." He further states that in, "Research of this type it is unwise to draw positive conclusions from preliminary data, however it does appear that we may have located some interesting variations between samples of fish meal that may prove very beneficial to the industry." In discussing results measured by particular diets used to date, Dr. Runnels comments that, "From a broad aspect it appears reasonable to conclude at this time that biological variations between samples of fish meal is smaller than had originally been thought."

Dr. Derse, of Wisconsin Alumni Foundation, is approaching the problem of measuring the possible variability of fish meals in quite another way. This work concerns determination of availability of amino acids through enzymic release. So far they have found that enzymic amino acid release follows a definite pattern. It is still to be determined if such patterns vary with the age and type of sample.

These comments, together with reports from other sources, indicate the validity of the approach made to the "Quality Index" program. There is less of a tendency to simplify the problem. Instead, it appears now that more basic work will have to be done. The massive data collected so far will probably be insufficient to arrive at a satisfactory solution to the problem. On the other hand, much of this information will fall into place when the picture becomes clear. Meanwhile, important bonuses are appearing along the way. Field work has increased interest in quality control at the producing plants. The nitrogen

partition studies of Dr. Vaughn have filled important gaps in our knowledge of composition variations of fish meals. The work on oxidation at the University of California and their finding of an effective antioxidant, relates directly to applied work being done in the menhaden plants. Meanwhile, some exciting concepts regarding methods of using fish meal in high energy rations have resulted from consideration of the feeding tests. If these conjectures can be supported by factual data then additional evidence regarding economic gains resulting from the use of fish meal in feed formulas can be expected.

We turn now to the extensive Saltonstall-Kennedy Fish Oil Research Program. This deals with a class of fats and oils which have received little technological attention in spite of long historical background. A fat which cannot be examined analytically and which is poorly understood chemically tends to occupy an inferior position in a competitive market. Interchangeability of fats and oils applies more frequently to the cruder uses. Fats selected for such purposes can often be described as being "good for everything, but good for nothing." The more valuable products resulting from fats and oils technology depend upon reliable raw materials of known structure and composition. Fish oils, with their long chain fatty acids, and high degree of unsaturation, will undoubtedly become valuable when fundamental information concerning them is available. Applied research, which develops more immediate markets, also has a place in this program. This again is not an easy path, since one must dig deeper than was required when Edisonian methods were in vogue.

The Fish Oil Research Program, as established in 1955, consisted of many parts. It included field work for collection of authentic samples, a literature search, and an analytical project concerned with showing variations occurring due to species, geographic locality, size and other causes. The greatest effort was to be devoted to basic research concerned with structure and analysis, composition, reactions, inclusion compounds, non-glyceride components and odor. Applied studies dealing with feeding, leather uses, fungicidal applications, resins and mineral flotation were also established. Although these projects cannot be completely discussed in a short paper let us outline highspots recently reported by the project leaders themselves.

Dr. Simmons, of North Carolina State College, is conducting a project intended to ascertain the variations occurring in fish oils as indicated by the usual oil constants (iodine value, color, refractive index, etc.). This work is being done on fish oils collected weekly from a large number of production areas and it is expected that the data, after statistical analysis, will be helpful to purchasers and users of fish oils.

Dr. Lundberg, Director of Hormel Institute, has furnished some information on the progress of projects under way in that institution. These were established early in 1955 to deal with structure and analysis of fish oil fatty acids, chemistry of the odor problem and separation of fatty acids by means of inclusion compounds. At the end of the first year the latter problem was replaced by another dealing with chemical reactions of fish oil fatty acids.

Dr. Privott and associates are concerned with the project on structure and analysis of fish oil fatty acids. In order to achieve a complete determination of structure of the more unsaturated fish oil fatty acids and to establish analytical constants for the examination of common fish oils they must isolate the individual fatty acids in purified form. Good progress is being made in doing this using methods which include solvent segregation, urea-complex fractionation,

distillation, and finally chromatography. By means of isomerization with alkali followed by spectral studies on various fish oils, and even more conclusively, through studies using soybean lipoxidase, they have established that at least 97 per cent (and possibly more) of the polyunsaturated acids of menhaden oil have double bonds which are separated by methylene rather than by ethylene groups. This implies increased reactivity which is distinctly important in many applied uses, particularly in the coatings field.

Another Hormel project involves the chemistry of odor and is being worked upon by Dr. Chipault and co-workers. Although commercial de-odorization processes are capable of complete removal of odor from fish oils, reversion soon occurs. Rather than attempt improvement of methods which may be basically wrong they consider it more promising to find out the chemical reactions involved, and then to seek additives capable of inactivating the causative factors. There is evidence that odor development in deodorized fish oils is due to liberation of low molecular weight substances which are nitrogenous, or which are formed by reaction of atmospheric oxygen with unsaturated fatty acids. There are indications that these are largely unsaturated carbonyl and dicarbonyl compounds. Selection of additives to destroy these odorous substances must await positive identification. However, one such additive may have turned up in the work on inclusion compounds. It was noted that thiourea is effective in removing peroxides. This finding could turn out to be significant since peroxides may be the precursers of the odor components. Thus the research work on one project can often be applied to advantage in the conduct of work in a related field.

Starting in 1953, the Seattle Fishery Technological Laboratory undertook a limited amount of work on fish oils, some of which was devoted to inclusion compounds of urea. There was interest in continuing this work at Hormel, and Dr. Schlenk and co-workers were selected because of their background in this field. Fatty acids have a peculiar property of forming solid complexes, or "inclusion" compounds with such substances as urea. This tendency varies with each fatty acid, offering an effective means of separating them. The potential is indicated by a recent Standard Oil (Indiana) process for separating petroleum hydrocarbons, based on similar principles.

In this project Dr. Schelenk placed most emphasis upon thiourea and deoxycholic acid. Neither of these compounds are considered practical because of cost, but they gave better separations than urea. An important result is that deoxycholic acid makes possible easy separation of fatty acids by chromatography. The purity of individual fatty acids, by this means, can be readily established. It was also used to demonstrate that the content of fatty acids of different chain lengths in menhaden oils is quite different from some of the published values.

Following completion of the inclusion compound project Dr. Schlenk was assigned another one concerned with new chemical reactions of fish oil fatty acids. Emphasis will be placed upon reactions occurring at the double bonds in an effort to exploit the long chain, highly unsaturated fatty acids present in fish oils, but not often available in such diversity and abundance in other fats and oils.

In view of the importance of analytical techniques a project dealing with development of a procedure for measuring some of the constituents of fish oils was established at Texas A & M under the direction of Dr. Raymond

Reiser. To quote Dr. Reiser, "It is hoped that studies on the chromatographic analysis of marine oils will be of value in evaluating the quality of various marine oil products by much simpler means than are now available. In a matter of a few hours it is possible to determine qualitatively and roughly quantitatively, (by the procedure developed) the various fat soluble vitamins, triglycerides, waxes, hydrocarbons and phosphlipids." Dr. Reiser's report states that menhaden oil was found to contain squalene, Vitamin A and D cephalin, but no lecithin, syphingeyelin, vitamin esters or waxes. The presence or absence of such substances is a matter of interest in many commercial applications. Another attack on these non-glyceride components of menhaden oil is reported by Dr. Mosher of University of Delaware. They have found so far that the non-saponifiable material in the oil, representing less than 5 per cent, contains squalene, chloresteral, and at least three other unidentified sterole-like substances. The non-saponifiable fraction is very subject to autoxidation and develops bad odor on standing. In line with the findings of Dr. Reiser, they report that several components of this fraction can be removed from the whole oil by chromatographic adsorption, including color body fractions. A good portion of the color associated with whole oil appears to be in the non-saponifiable portion. The presence or absence of substances of the type covered by the latter two projects is a matter of interest in many commercial applications.

Turning now to some of the applied research projects we find some interesting reports from some of these investigators, dealing with insecticidal and fungicidal uses, leather uses, ore flotation and with the feeding of fish oils to swine:

Dr. Sokoloff, of Florida Southern College, has found that menhaden oil exerts anti-fungal activity and that this activity can be increased by fortifying with hydrides. This "hydrogenized" menhaden oil has proven non-toxic for citrus seedlings and active against citrus fungi and certain citrus insects. For convenience in use, an attempt is being made to produce the product in powdered, water-soluble form.

Messrs. Roddy and Mattei, of the Tanner's Council Laboratory, University of Cincinnati, are conducting experiments on the use of fish oils in the fat liquoring of leathers. Tanners have objected to menhaden oil because of its high degree of unsaturation and oxidative properties. Preliminary tests involving fat liquoring of leather with menhaden oil have produced better results than expected. This work is to continue, using various modified menhaden oils. Also, the trade has reported objectionable features to this oil in connection with sulfation processes. By introducing an additive to concentrated sulfuric acid they have developed a better procedure for sulfating menhaden oil and are preparing to test this procedure on a pilot plant scale.

In quite another field, it is interesting to consider Dr. Cooke's investigation at University of Minnesota, on utilization of derivatives of fish oils in ore flotation. The objective is to extend the usefulness of these products and their applicability to ore concentration by flotation. Dr. Cooke points out many variables involved in this work and the difficulty of drawing firm conclusions based upon incomplete results. It appears so far that "the bulk unsaturated fatty acids seem to give as satisfactory results as a relatively pure (93 per cent) technical grade oleic acid. Comparative tests have been made using commercial grades of oleic acid, but analysis of the results are not yet available." These results seem promising. Less encouraging is his comment that work done with

purified acids prepared by Hormel Institute indicates that best results are obtained at iodine values of 80 to 120. Adequate selectivity is not obtained at higher or lower levels.

The last of the applied research projects discussed in this paper is concerned with feeding of fish oils. This subject is important to the menhaden industry because it serves to expand our knowledge of the nutritional possibilities of menhaden oil, for humans, animals and poultry. The part that unsaturated fats may play in the prevention or treatment of coronary heart disease recently received national attention through an article appearing in the November 12 issue of "TIME" magazine. Our interest also stems from the fact that fish oils, and their counterparts in fish meal and solubles, have proven useful in animal and poultry rations when used at proper levels. Fat content of fish meal and solubles is a useful energy source contributing to the caloric value of the ration. One of two projects involving feeding of fish oils was concerned with its use in swine rations. This was conducted by Dr. J. E. Oldfield of Oregon State College. He found that swine grow satisfactorily when 5 to 10 per cent of the grain is replaced by crude fish oil, but that 15 per cent causes them to go off feed. He found that even 5 per cent levels of crude and alkali refined fish oil will impair carcass quality from the standpoint of flavor. Five per cent kettle bodied oil, on the other hand, produces vastly improved carcasses. Dr. Oldfield feels that adequate protection of the oil prior to feeding, perhaps through polymerization, might eliminate the undesirable effects upon carcass quality. It is difficult to say where these findings may lead. Present practice would involve use of only small amounts of fish oils in swine rations and presumably, insofar as he has studied the problem, the quantities introduced as a part of condensed fish solubles, or fish meal, are too small to be significant.

In conclusion it is well to restate a portion of what has been said about the impact these fish meal and oil studies are having upon the menhaden industry. It is evident that many of our research objectives are being met. Our knowledge of the raw material menhaden is increasing as a result of field work which seeks well documented samples for extensive chemical, physical and nutritional evaluation. The selection of samples having known processing variables has stimulated interest in taking a long, hard look at some phases of the reduction process. This re-examination of old concepts regarding processing has already brought about some improvements. There is a daily increase in our knowledge of menhaden products resulting from the fish meal and oil program. Such knowledge is coming to us in the form of extensive data relating to composition, physical properties and biological activity, and also in suggesting improved methods of utilization. These findings offer the promise of increasing the effectiveness of fish meal in animal and poultry rations, a result which would further prove the economic value of this important product.

The basic studies seem to be leading directly to some of the more valuable applications of fats and oils. The applied projects, in delving deeper into specific fields, appear to be bringing us within striking distance of new and important outlets for fish oils. This progress, in so short a time, is a source of satisfaction, and certainly a tribute to the people concerned with this program.

Oxidative Deterioration in Fish and Fishery Products

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A RESEARCH PROGRAM on oxidation of fish and fish products is being supported by Saltonstall-Kennedy funds at the Davis and Berkeley Campuses of the University of California. The following is a report of work now being done by W. D. Brown, E. Einset, W. Venolia, A. L. Tappel, and H. S. Olcott.

Fish oils are particularly susceptible to oxidative deterioration due at least in part to the high degree of unsaturation of the fatty acids. In frozen fish products, oxidation leads to deterioration in flavor and color; in fish meals the oxidation of oils may be responsible for changes in nutritional value; in fish oils, the oxidation leads to rancidity with subsequent loss of value. In order to develop methods for controlling these unwanted reactions, it is necessary to understand the various factors involved.

Hematin compounds, such as the pigments of blood or muscle, accelerate the oxidation of systems containing unsaturated fatty acids. Studies on the amount of hematin compounds in fish and their effect in accelerating the rate of oxidation of emulsions containing fish oils suggest that they are important catalysts for oxidation of fish lipids. They are in fact probably the most important pro-catalysts in fish, since no evidence has been found that fat oxidation-promoting enzymes, such as lipoxidases, occur.

Tocopherols (vitamin E) inhibit the auto-oxidation of fish oils and also the hematin-catalyzed oxidation. No detailed study has been reported on the occurrence of these substances in fish or in fish oils. Such determinations are now being made. The data indicate that fish oils contain variable amounts of tocopherols and that the tocopherols contribute to the stability of the oils as measured by the length of the induction period (length of time until the fat begins to oxidize rapidly). In general, of two oils of similar iodine number, the one with the higher tocopherol content appears to be the more stable. On the other hand, the few exceptions which have been observed suggest that other anti- or pro-oxygenic factors may be present in some fish oils. The sable fish yielded the most stable fish oil encountered as yet—one which had both a low iodine number, 100, and a high tocopherol content (625 mg/100 gm). Experiments to determine the relative antioxidant effectiveness of the seven different naturally occurring tocopherols, and their occurrence in marine products are in progress.

Studies of the interaction of mixtures of different type antioxidants have revealed that under some circumstances synergism is very marked. Hematin-catalyzed unsaturated fatty acid oxidation, for example, is slowed down by tocopherol and ascorbic acid separately, but practically stopped by mixtures. Not sufficient is known about the numerous possible combinations to predict the most effective mixtures for the different products.

Of a number of commercial antioxidants assayed both in oils and in meals, 6-ethoxy,-2,2,4 trimethyl, 1,2-dihydroquinoline (Santoquin) was the most effective. In fish oil, for example, Santoquin appeared to be 5 to 10 times more effective than BHA (butylated hydroxyanisole) or BHT (butylated hydroxytoluene), under the conditions used for the assay (50°C). The use of Santoquin has not yet been sanctioned as an additive for feeds or foods.

"Green" tuna, a color problem which occasionally is a serious cause for rejection, appears to be an oxidative phenomenon. With the use of spectrophomometric methods it has been shown that the pink color of cooked tuna flesh is due to the presence of *hemochromes* derived from myoglobin or hemoglobin in the raw tissue. The hemochromes are probably denatured globin hemochromes in which nicotinamide may play an important role. Oxidation leads to the formation of *hemichromes* which are tan. These can be reduced by simple reducing agents to the hemochromes. The "green" of off-color tuna is at least in part *hemichrome* since "green" tuna samples can be reduced to pink under appropriate conditions.

Royal Red Shrimp—A New South Atlantic Resource

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FOLLOWING THE 1955 FALL meeting of the Fishery Advisory Committee favorable consideration was given to an industry-sponsored request for shrimp exploration off the south Atlantic coast. A sum of $60,000 was allocated from Saltonstall-Kennedy funds to be used for chartering a vessel suitable for exploratory work, hiring a crew, and providing the necessary gear and operating funds. This sum was sufficient to carry out a short range program, lasting through June, 1956. The programming was carried out under the supervision of the Service's Gulf Exploratory Fishing office.

While steps were being taken to obtain and rig a vessel, a comprehensive review of previous offshore investigations in the area under consideration was undertaken, both by reviewing the meager literature, the rather extensive unpublished station records from previous Service work in this region, and State reports on localized projects, and by personally interviewing large numbers of fishermen and fleet owners that fish the south Atlantic coast the year around.

It was found that previous work had extensively covered the continental shelf out to 100 fathoms without extending the known shrimping areas or, with the exception of finding scattered, small rock shrimp (*Sicyonia brevirostris*) beds, had not succeeded in locating new species for possible commercial exploitation. Other points of interest were that commercially valuable stocks of fish were disappointingly small or absent and that practically all previous exploratory work had been accomplished in the winter and spring, with little summer or fall coverage.

On the encouraging side, examination of the depth-temperature data collected in recent years by the Service's M/V *T. N. Gill* between Cape Canaveral and Cape Hatteras revealed several areas having depth-temperature patterns very similar to those in the Gulf of Mexico red shrimp grounds. A few bottom samples from these depths were similar to the red shrimp bottom off Dry Tortugas. Further, it was found that scattered individual specimens of red shrimp (*Hymenopenaeus robustus*) had been collected many years ago along the east coast as far north as Georges Bank, which suggested that this species might be found in greater concentrations. Therefore, with only four months time to carry out the program, deep water exploratory coverage was given primary emphasis. To

provide supplementary information on shallower water, the Service's M/V *George M. Bowers* was employed during January, February, and March.

In February, the M/V *Pelican,* a 70-foot, 170 H.P. steel-hulled shrimp trawler, was obtained on a bare boat charter. A larger winch, gallows frame, loran, and deep-water depth recorder were installed, and a crew was recruited.

"Maximum effort" fishing plans were formulated to obtain as much exploratory coverage as possible from Cape Canaveral to Cape Hatteras, with the intention of following up promising leads as they might present themselves. The initial trip, of a semi-shakedown nature, resulted in 13 drags being made between Ft. Pierce and St. Augustine in 20 to 235 fathoms, with eight out of nine drags in the theoretical red shrimp depths successful in catching small quantities of this species. April, May, and June were spent expanding coverage to the north, and by the end of June an area off St. Augustine, in depths of 160 to 200 fathoms, had been located that yielded catches of good commercial promise. Although several efforts were made to tow against the Gulf Stream current, only one short period of apparent slack current permitted successful counter-current dragging, and all other dragging efforts were made running with the current.

Of course, considerable information concerning trawlable bottom was acquired by this time. At the expense of five complete rigs lost, as well as some 5,000 feet of trawling wire, it was found that loose slab rock was encountered immediately north of St. Augustine, in red shrimp depths, and off Jacksonville and northward slab rock concentrations prohibited trawling with standard shrimp trawls. A single successful drag off Savannah in May in 182 to 250 fathoms caught 13 pounds of red shrimp, showing possible concentrations at least that far north. Since time did not allow extensive gear experimentation, the remainder of May and June were spent obtaining more information of commercial aspects of red shrimp fishing between Cape Canaveral and St. Augustine.

Much of the gear used for this work was of the same design and construction used on the M/V *Oregon* for red shrimp exploration in the Gulf of Mexico. (A report on the Gulf work is now in press and will appear shortly in Commercial Fisheries Review.) Generally speaking, 40-foot flat shrimp trawls were used for all exploratory dragging. These were towed on 5-foot trawl doors using a 25- or 35-fathom bridle on a single trawl warp. We tried to anticipate some of the special problems of dragging in the strong Gulf Stream current and designed and built a modified beam trawl, much like the Blake trawl—that would fish properly on either side. This net has been used several times with some success, but there has been no apparent advantage to it over the standard flat trawl.

As soon as areas of commercial promise were located, larger trawls were used, including 56-, 70-, and 80-foot nets. The rigging arrangement on the *Pelican* made it most advisable to run these larger nets on a single warp and bridle also. Early trials with these larger nets brought in catches of only slightly greater poundage than were made using 40-foot trawls.

By the end of June, results indicated the possibility of extensive and commercially profitable deep-water shrimping grounds off the northeastern Florida Coast, and additional Saltonstall-Kennedy funds were provided to extend the work for another year. At this time the vessel charter was changed to the M/V *Combat,* which probably could be considered the best equipped shrimp boat in the Gulf of Mexico. The *Combat* has a 96-foot wood hull, a 500-horsepower main engine, emersion freezing equipment with a large refrigerated

hold, complete electronic equipment including loran, radio, and depth recorder, and a large New England trawling winch with heavy gallows frames on port and starboard quarters. In seaworthiness, power, equipment, and rigging, the vessel was ideally suited to the job, permitting fishing activities to be continued when smaller vessels would be forced by weather to head in to port.

First successful attempts to trawl against strong current conditions were made during the shakedown cruise in July. It was found that the 2.5 to 3.5 knot ground speeds that could be made dragging against the current yielded, on the average, much better catches than were made towing the minimum speed of 4 to 4.5 knots with the current. Four days of round-the-clock fishing off St. Augustine, using a 40-foot trawl, caught 21 boxes (100 pounds of headed shrimp per box) of 21-30 count red shrimp. Drags were made of three to four hour duration, alternately with the current and counter-current. Most catches ran from 200 to 450 pounds of heads-on shrimp. The best catch yielded 560 pounds of shrimp, from a four hour counter-current tow. Highest catches were made immediately below 29°58.5′ north latitude, in 170 to 190 fathoms. To the north of this point slab rock and coral prohibited trawling.

Use of larger commercial trawls gave slightly better catches but the poundage increases did not seem commensurate to the 40-foot nets. Experimental fishing using two 40-foot nets simultaneously has been tried, and has proved moderately successful. Further work on this is now underway, though there is an apparent drawback in that at least one additional fisherman will have to be added to crews working two rigs.

In September and October emphasis was placed on more closely delineating potentially profitable areas, and at this time two commercial shrimpers tried working the St. Augustine grounds. However, following the turbulent seas that accompanied the passing of Hurricane Flossie, the large concentrations off St. Augustine apparently dispersed, and commercial efforts were discontinued. The largest catch in that area by the *Combat,* during this period, was 280 pounds of shrimp from a three hour tow. Working to the south, in the offings of Daytona Beach, concentrations of up to 400 pounds per drag were located, but with a definite size groupings of shrimp that had not been encountered previously either on the east coast or during some five years of deep-water dragging in the Gulf of Mexico. In late September and mid-October catches of red shrimp were about equally divided by weight into 21-30- and 51-70-count. In the Gulf of Mexico, small *H. robustus* have been caught in insignificant quantities throughout most of the year, causing speculation that perhaps this species spawns throughout the year. To further this theory was the fact that many catches contained individuals in every size grouping from about 10 or 15 count on down to 50 to 70 count. This size demarcation on the east coast indicates that there might well be a seasonal factor to their spawning, and also raises the question of the advisability of fishing in areas where young shrimp predominate. Since work on the east coast has been under way less than nine months, the seasonal picture is still far from complete.

In November, the *Combat* concluded a three-week trip concerned with deep-water exploration in the Cape Fear to Cape Hatteras area. Although bad weather greatly restricted fishing operations, 14 fishing stations were made in 125 to 250 fathoms. Most of the drags yielded a few red shrimp but the quantities were disappointingly small. The best catch was three pounds of heads-on shrimp. Of interest, however, were small numbers of other peneid

shrimp, identifications of which have not been made as yet. It is planned to investigate this area again next Spring.

To date, three commercial vessels have worked the red shrimp grounds off northeastern Florida, and their results have provided interesting and valuable supplementary information. In early August, the first commercial boat made several unsuccessful attempts at trawling in the Gulf Stream current using two trawling warps. The principal problem was twisting and fouling of the doors, net, and wires during setting operations. Following this, in early September, one of the Sahlman Seafood Company boats that had been rigged with a large Hathaway winch, and using a tipping gallows frame device that had been developed on the first boat, made four short trips off St. Augustine. They were able to trawl successfully using two warps in the conventional manner, and several good catches were made using large, commercial trawls. In mid-September, their catches averaged some 400 to 500 pounds of headed shrimp per day. However, following the bad weather that accompanied Hurricane Flossie and the dispersal of shrimp off St. Augustine, this vessel also discontinued deep-water fishing.

The third vessel to work this area was an off-shore trawler, the *Sarah J.*, based in New Bern, N. C. Their work was carried out during the second and third weeks in November, while the *Combat* was engaged in exploratory trawling off Cape Lookout. The reports received tell of their catching very large quantities of small (approximately 50-60 count) red shrimp in 175 to 250 fathoms off New Smyrna to Cape Canaveral.

To summarize the information we have to date, good trawling bottom and fishable concentrations of red shrimp have been found from Daytona Beach northward to St. Augustine, where bad bottom is the limiting factor. Good bottom but smaller concentrations of red shrimp extend south of Daytona Beach to off Ft. Pierce. North of St. Augustine, small catches of shrimp show that they range extensively along the coast, at least to Cape Hatteras, but bad bottom has greatly restricted exploratory coverage. There also appears to be a seasonal factor on the average size of the individual shrimp. It must be recognized, however, that this tentative summary is based on only eight and one-half months of work, and that as further work is carried out, the picture might change considerably.

As a fishery resource, red shrimp provide a new, tasty variety to the existing shrimp industry. Several trial servings of this species have been made in the Gulf area during the last few years, with enthusiastic results from both seafood restaurants and individuals. On the other hand, the smoother, softer texture of red shrimp apparently requires some special processing, handling, and cooking techniques, which could be disadvantageous if the initial market offering did not take this into consideraton. There is also a 10 per cent smaller meat yield per pound of heads-on shrimp. This is due to a proportionately slightly larger head and a slightly greater water loss following processing. Our information on this is incomplete, however, and the Service's Technological Section is currently carrying on studies that will closely define yield and quality versus handling.

To attempt to delineate the magnitude of the new grounds, in terms of continuing yield, would certainly be most premature at this time. Perhaps the most significant accomplishment has been the addition of a third area where commercially profitable catches of this species of shrimp have been

made. (East of the Mississippi Delta and southwest of Dry Tortugas in the Gulf of Mexico.) By next summer, when some repeat seasonal coverage has been made, a much better picture should be available. Also, it is very probable that within the next few months intensive commercial fishing will be carried out on these grounds, providing some early tangible data on commercial possibilities.

DISCUSSION

Exploratory Fishing and Technology Session

Discussion Leader: LAWRENCE W. STRASBURGER

Discussion Panel: FRED JUNE, LEO LEVINSON, E. A. FIEGER, PHILLIP S. WOOD

A New Federal Fishing Laboratory on the Gulf

CHARLES BUTLER

Q. Strasburger: How many people will you have at the Pascagoula Laboratory?

A. Butler: The personnel will be designed around the program, but will have three people initially. A qualified director will work in the area to find out what are first priority projects. We will also have a chemist and a bacteriologist.

Q. June: Considering the rapid deterioration of shrimp on boats, would it not be useful to investigate the possibility of some pre-processing of the product on the shrimping grounds; that is putting gear aboard the vessels which would make available to the market a better product?

A. Butler: That is, in effect, what we were trying to do a number of years back with freezing at sea. We also tried with fin fishes to develop techniques for filleting and freezing the fillets in a package at sea. But there are two problems, the amount of manpower aboard the vessel, and the degree of skill involved. It is asking a lot of the fishermen, who know only how to fish, to do these other types of work. In the Gulf there is difficulty with refrigerated vessels because the personnel do not know how to handle refrigeration equipment. If you go to the next stage of asking them to do something with the product which involves shore processing knowledge, that is a big order for the small crew of a shrimp boat. With a larger vessel you have a still bigger investment, more people involved, and hence larger expenses. So we feel that by the application of good practices of handling and sanitation we can best get a product back to shore. On the basis of work that has been done on fin fishes, we think that this can be done. If it proves unprofitable or unfeasible, we then have to find another solution.

Q. Miller: I am interested in getting a yardstick of good handling practices from the viewpoint of the antibiotics. Antibiotics are primarily bacteriostatic, rather than bacteriocidal so a low bacterial count is important. In Canada we have some rules to live by, and the rules imply very good handling practices in the industry itself. In this country are good handling practices, which you develop through research, going to be followed up by industry and are they going to be a yardstick that we can use in our new developments with the use of antibiotics in fish?

A. Butler: We work in research and we are not an enforcement agency. We certainly will come up with recommended practices where we find that practices could be improved. There is a lot that could be done in improving fish quality with what we already know. It is a matter of education and constant re-education. Personnel and circumstances will change and you have to go right back and start the education over.

Progress in Technological Studies on Menhaden Products Under the Saltonstall-Kennedy Program

THEODORE M. MILLER

Q. June: Have there been any studies to determine the bacterial load of the dried scrap as it comes from the dryer?

A. Butler: We have made a study of the bacterial flora on the meal at various stages. It is practically sterile in the pile and the effect of bacteria during the curing stages is absolutely nil. Any changes which we observe must be due to oxidative changes in the oil, or some combination of the protein and the oil, rather than bacterial changes.

Q. June: We know at certain times that there is a great loss in the raw product due to spoilage. Would it be practical to use refrigeration for cooling the fish at the time of capture?

A. Sturgis: Results of work done along those lines are inconclusive, but they look promising. The costs of refrigerating the vessels are substantial. Also, we do not know yet exactly what the difference may be in the quality of the end products from fresh fish and spoiled fish. Of course, there is no doubt that there are substantial physical losses because of deterioration of fish, particularly in the Gulf area where temperatures and humidity are high.

Q. Strasburger: You said you are trying to establish a quality index and you also said you are establishing quality control. Now without a quality index already established, how can you establish quality control?

A. Sturgis: Initially, the program was designed to develop a quality index for fish meal. We recognized that this was going to be an extremely complex problem and we knew that the soy

bean industry had come against a solid wall despite the fact that they were working with a product far less complex than ours, a product that could be controlled from the point of sowing the seed, to manufacture. With us this is not possible, and we have large variables in our raw material. So, recently we have changed our attack and are doing some more basic work. This is to determine more exactly what components make up the fish meal and their availability to the animal eating them. Hence, our "quality conrol" refers to standards for the finished product, not control of methods of manufacture. We are interested in broadening the market for fish meal and finding other uses for it. To do this, we have to describe the product more carefully and control its uniformity.

Fellers: This new approach is an important one, but I don't see where we are going unless we change the ideas of the feed purchasers and persuade them of the worthwhileness of paying more for improved feeds. You can't convince a fish meal producer that he should change his equipment when he can't get any more money for the new kind of meal. It is possible to produce a very good quality meal that may be used ultimately for human consumption, but I doubt that it will happen in this country.

Sturgis: (Comment) There is no question that it is extremely difficult to persuade a feed manufacturer that one meal is particularly different from another. On the other hand, feed manufacturers are becoming more and more conscious about quality. For certain purposes there is no question that some feeds without any fish meal can do the same kind of a job that can be done with fish meal. There must be a certainty of the amino acid content, both as to kind and quantity, and we have to establish ways of determining this on a standard basis.

Progress in Studies on Oxidative Deterioration in Fish and Fishery Products

HAROLD S. OLCOTT

Q. Strasburger: How did you measure the tocopherol content of the oils you studied?

A. Olcott: The method we used is a modification of a colorimetric method, the Emmeric-Engel method. It supposedly measures total tocopherol. There are now seven different tocopherols known to occur in nature; these have different biological activities and different antioxidant activities. We are interested in finding out what tocopherols occur in fish oil, and in determining whether their antioxidant activities can account for the stability of the fish oil.

Q. Levinson: Is there any study being made of side reactions that follow

the use of antioxidants for control of discoloration or rancidity?

A. Olcott: The amount of antioxidant used is of the order of 1/10 to 1/100 of a per cent, or less, and therefore it is very unlikely that there would be any secondary reactions which would adversely affect the proteins, the texture or other characteristics. Their acceptability in food stuffs depends upon agreement that they are completely harmless at the levels to be used.

Q. Bullis: Your slides seemed to show that discoloration in tuna is a question of processing. In talking with people in the California tuna canning industry they maintained that the Japanese tuna that they are importing into the country, each had a very large notch immediately behind the second dorsal fin and they assume that it was made by the Japanese to check the quality of the meat, so that the shipment of green fish or bad fish would not be made. They maintained that the imported fish very seldom turned out to be green or discolored. Apparently some test can be made on raw frozen tuna to determine if they are going to cook out green or discolored. That would seem to be contrary to the work that you described this morning.

A. Olcott: Some of the green tuna that we have looked at have been supplied to us by a firm in San Francisco which uses nothing but Japanese imported tuna; so the Japanese imported tuna are sometimes green too. The Japanese have done a lot of work on attempting to identify in advance whether tuna would turn green and a paper has been prepared by Japanese workers who claim that a measurement of the myoglobin and hemoglobin pigments in the tuna will give a definite method of judging whether it will turn green. However, a Fish and Wildlife Service man from Hawaii tells me that one of the authors of this paper visited an Hawaiian tuna plant and tested fish for potential greenness. Guessing would have yielded better results. Hence this test is of doubtful significance at the moment. However, we are definitely not of the opinion that greenness is primarily due to processing.

Bullis: I have seen some figures on the percentage of green fish from the western Pacific Japanese tuna fishery and they have about 30 per cent of green fish. Other figures indicate that the fish imported to the Pacific coast run about 5 and 10 per cent, so that would seem to indicate that someone is doing some good guessing or the test must have some value.

A. Olcott: The larger the fish is, the more chance there is that it will be discolored. The imported tuna that we have seen have not been very large ones. That may or may not explain it.

Butler: It is only fair to state that most people don't really know what they mean by "green" tuna. There are two problems

actually; one is the true green tuna which has odor, texture and color differences from normal fish. The other is just a coloration which here in the Gulf means nothing in terms of true quality of fish. The Japanese are only working on the true green tuna and have been for a number of years. I agree with Dr. Olcott that they have so far not been very successful but they are still trying and so are we. Eventually we might come up with a simple test. If the test is complex it is just as worthless as the objective test that the Food and Drug uses, because you cannot use it in the field work. We hope that the type of work being done at the University of California will eventually give us the answer to the chemical problems and then we can work back from that to a procedure that can be used at the plant level or even aboard the vessel.

Q. Strasburger: Your last slide seemed to infer that the discoloration in tuna might be reversible. Is that correct?

A. Olcott: Yes.

Q. Strasburger: Is there a possibility, then, since it was inferred that "greening" might be an oxidation process, that greening could be reversed also?

A. Olcott: Yes.

Q: Strasburger: Has it been tried?

A. Olcott: It has been tried in the laboratory and it is possible to get a reversion to the pink color by the addition of a reducing agent, and by the heating which takes place in the process of canning.

Q. Strasburger: I have noticed the presence of an off-odor attached to green tuna. Is that odor eliminated in the reverse process?

A. Olcott: I don't know, but I would doubt it. While many odors in tuna are reduced or eliminated in the cooking, and precooking, it is not reasonable to expect that the reducing agent would have an effect on the odor. It also could not be expected to take care of any texture problem,

Royal Red Shrimp - A New South Atlantic Resource

HARVEY BULLIS

Q. Levinson: You mentioned the differences in texture and taste in comparing the red shrimp with those now in commercial use. Can you give us a little more information on this?

A. Bullis: There is only preliminary information available. However, if red shrimp is cooked in the same manner as brown or pink shrimp, the meat gets soft. If the cooking time is shortened the shrimp maintains its quality and remains tender. Over-frying tends to harden the flesh, and a shorter frying time than that used on regular shrimp is required. When the new laboratory is complete in Pascagoula we can carry out more extensive tests.

Q. Levinson: How about differences in plant handling?

A. Bullis: The red shrimp seems to be a little softer when it is alive. Under these circumstances the normal procedure of filling a whole bin with crushed ice could mutilate the red shrimp tails more easily than regular shrimp.

Q. Levinson: Is this softness similar to that found in pink shrimp which is called "soft shell"?

A. Bullis: No, the meat is just softer. When fish are brought up from very deep water the meat is usually soft and mushy. Whether this is a problem of pressure or not, we don't know.

Strasburger: (Comment) Some time ago in a comparative cooking test we found a higher weight loss due to cooking in the red shrimp than in any of the other presently used species. We had about 15 to 18 per cent less cooked weight on the red shrimp than we did on the pink shrimp or brown shrimp. Another point is that the red shrimp will not peel well and looses its red pigment in peeling and canning.

Q. Stein: Do you cook the shrimp prior to peeling or do you peel them raw?

A. Strasburger: They are peeled raw.

Stein: (Comment) The shrimp pigment is situated in the layer termed the hypodermis just under the shell and I have noticed that heating in cooking causes the pigment to adhere more strongly to the muscle. It might aid in color retention if the royal red shrimp were pre-cooked prior to peeling.

Strasburger: You are correct. However, we have found that pre-cooking makes peeling more costly and difficult. The present large volume of shrimp being handled and the hardness of the cooked tails do not allow clean peeling. The design of the peeling machines in use now require soft raw tails for maximum peeling efficiency.

A. Bullis: If the red shrimp is handled and sold as are the other shrimp, it will not retain its identity or its appeal as a specialty product. If, however, care is used in handling, cooking, processing and marketing, it can meet with widespread approval, as has been demonstrated by us in local restaurants along the Gulf coast.

The cooking loss is a problem in some areas since buyers feel that the specialty value cannot be high enough to cover the loss due to shrinkage in cooking. Other buyers and dealers feel that the eye and taste appeal of the red shrimp will enable it to command a premium over the species now being utilized.

Q. Strasburger: Did you find that the red color might meet consumer resistance under the excuse that is was spoiled shrimp?

A. Bullis: No. In all cases where trial lots were distributed, the

people were aware that this is a new species and were eager to try it. Comments have all been favorable.

Q. June: Do you have any estimate of cost for conversion to deep sea trawling for the royal red shrimp?

A. Bullis: Yes. A lot depends on where the conversion starts. If one already has a vessel with an ordinary winch, an outrigger boom and warp, one is faced with the prospect of selling this equipment and installing a deep water winch and cable, which involves an initial expense of $1500 to $2000 for a winch plus an added $500 to $1000 for wire, depending on whether single or double warp is to be used. Standard trawls and doors are used, with the addition of extra weight on the doors. An added expense would come with the need for an adequate depth recorder and Loran set. One can buy a used Loran set for $175 or a new set for $3500. The initial total outlay would probably run from $4000 to $8000. The cost of outfitting a new vessel would probably be less than re-conditioning and outfitting an old one.

Q. Levinson: For the commercial fishermen who are interested in the royal red shrimp from a production end, do you know the seasonal and geographic patterns of distribution?

A. Bullis: Yes, to a certain extent. A report is now in print which shows what we have found in the Gulf of Mexico for the years 1950-1956. We have some grounds charted and we have some data which shows the seasonal catch rates on these different grounds. In the Gulf, between the Mississippi delta grounds and the Dry Tortugas grounds, production can apparently be maintained on a year-round basis, although the winter time has a generally lower catch rate than the summer. On the east coast we haven't worked a full year and have conducted production dragging only during five months, but apparently there is a decrease in numbers of large shrimp and an increase of small shrimp in the late fall. Whether these small shrimp will reach a high enough count to be of value by February or March when the bad weather is over, still remains to be seen. A report on the East Coast findings will probably be prepared as soon as one full year of commercial type fishing has been carried out.

Q. June: What is the presently known range of this species?

A. Bullis: A single specimen was caught off Georges Bank about a year and a half ago. That is the only capture above Cape Hatteras that I know about. It would seem that southern range extends down into the Caribbean on the outside to about the Virgin Islands. This record was taken from a dredge haul made back about 1880. Large quantities of red shrimp were also caught in dredge drags off Brazil. I got that information from a captain's log while I was in

Washington. This log gave no scientific name but the description fits this species very closely. Large populations of this species are found from Cape Canaveral to St. Augustine in a small area S.W. of Dry Tortugas and east of the Mississippi delta. Some traces occur all around the Gulf of Mexico, but commercial quantities do not exist in all areas.

Q. June: What are the maximum and minimum depths at which the red shrimp occur?

A. Bullis: Preliminary data shows a range of 150 to 400 fathoms with 99 per cent of the captures being taken between 190 and 300 fathoms.

Q. June: Do the red shrimp occur with any "indicator" organisms?

A. Bullis: Not throughout the entire range of red shrimp. There are definite local faunal associations but these associated animals may be different in different areas.

Q. Fieger: How long does it take to drop the net and to recover it in deep water?

A. Bullis: It takes 10-15 minutes to drop 700 fathoms of wire over, and about half an hour to retrieve it. Winch speed will, of course, govern the haul-back time. We have used long drags—up to five hours—in deep water because of this lost time factor. This extra trawling time is possible due to the apparently small amount of trash found in deep water. We have found little correlation between day and night catches, so the fishing can be carried on 24 hours a day in the Gulf.

Q. Costello: Have you records of the catch you made in pounds per hour and can you say when it is possible to fish for the red shrimp profitably?

A. Bullis: We have tried to break down our catches into pounds per hour. We have shown how bad, how good and what our average catches have been. It must be remembered, however, that our aim has been to mark out the bounds of good and bad fishing areas, hence we have left good fishing many times to explore new areas. For this reason it is difficult to extract any estimate of commercial potentialities from our data. We have found that in the Mississippi delta area we average about 25 to 38 pounds per hour, with many individual catches much higher. The low rate is in the winter, improving to a high in the fall. The best catches in the Tortugas run about 180 pounds per hour. On the east coast for several months now we have produced close to 100 pounds per hour. We have caught up to 800 pounds of tails per day. Where the economic breaking point is I do not know. The prices will decide whether it can be a paying proposition.

Q. Stein: Can you elaborate on your statement regarding the temp-

erature of the water where you catch these shrimp and its importance to the fishery?

A. Bullis: We have found that without exception our good catches have been taken in water that ranges from 47°-52°F., and 210-270 fathoms. A temperature of 50°F. is apparently optimum.

Butler: (Comment) It might be of interest to note that the red shrimp must be headed quickly to prevent discoloration of the flesh by the exudate from the body.

WEDNESDAY—NOVEMBER 28

Chairman—CHARLES E. JACKSON, *General Manager, National Fisheries Institute, Washington, D. C.*

Some Findings on Insurance Experience of Commercial Fishing Vessels in The Gulf of Mexico

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THIS PAPER is an early and brief report of an intensive survey of insurance experience of commercial fishing vessels in the Gulf of Mexico area.

The survey is part of a nation-wide study which, in addition to the Gulf of Mexico, covers the New England and California fisheries. It is sponsored by the Fish and Wildlife Service of the United States Department of the Interior. The major researchers and authors of this report are deeply indebted to Dr. Richard A. Kahn and his staff for their cooperation. Gratitude is also expressed to the three advisors of the study, Professor Ralph H. Blanchard, Insurance, Columbia University; Dean Donald J. White, College of Business Administration, Boston College; and Dr. James W. Kelley, Director of the Bureau of Business Research, Boston University, for their useful advice and constructive criticism on planning the project and reporting the findings. Finally, it is admitted that without the hard work done by the field supervisors, Professors David J. Ashton, Robert M. Campbell, Myles S. Delano, Francis S. Doody, and Albert A. Thompson; research staff; and field workers, the cooperation of the interviewed vessel owners, insurance agents, and firms, success could not have been secured.

The principal method of collecting information for this survey consisted of two steps. First, the vessel owners of a systematically selected sample of 225 vessels operating from ports located in the Gulf of Mexico were personally interviewed. Second, the insurance experience of these vessels was intensively and carefully studied for the five-year period, 1950-1954. A detailed account of the attempts to obtain reliable information on the subject appears in the Appendix.

Here we deal with three limited topics. First, we examine the overall situation between noninsured and insured vessels. In turn, we present a few significant differences between these two groups of vessels in relation to their physical and other characteristics. Finally, we attempt to give a bird's eye view of the insurance problem in terms of insurance cost and categories of accidents.

I. NONINSURABLE vs. INSURANCE.

With regard to the first topic of noninsured versus insured vessels, two basic questions may be raised. How many vessels have carried insurance and what kind of insurance has been carried on these vessels during the period from 1950

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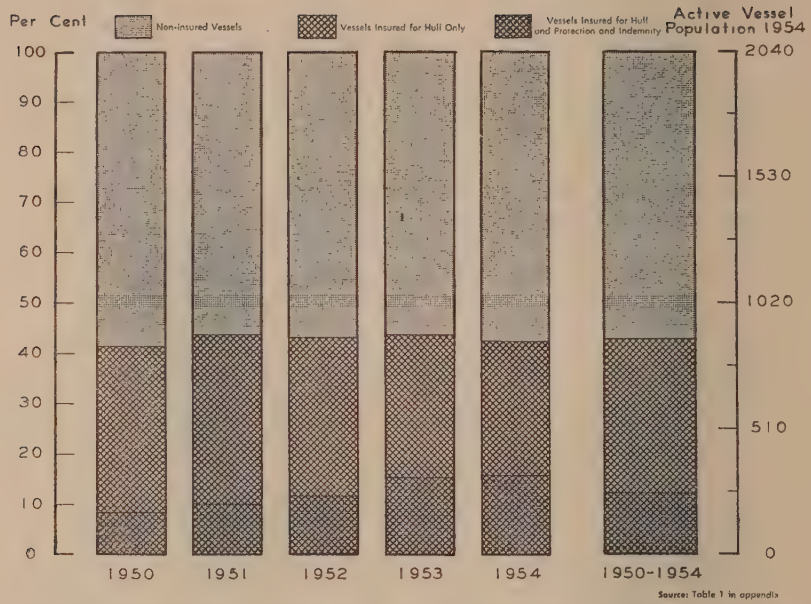

FIGURE 1. Noninsured and insured vessels, Gulf of Mexico fisheries, 1950-1954.

to 1954? What major observations can we make in connection with the findings on this subject?

1. Proportion and Number of Noninsured and Insured Vessels. The findings of the sample indicate that an average of 42.4 per cent of the active vessels were insured for Hull.[2] Reading from the left-hand side scale of Figure 1, you may notice that this percentage has changed little during the years 1950-1954. The percentage of vessels which carry Protection and Indemnity Insurance[3] is much smaller than that for Hull Insurance. It averages only 12.2 per cent for the period in question, but this percentage increases steadily from as low as 8.3 per cent in 1950 to as high as 15.7 per cent in 1954.

According to our best statistical estimates, no more than half of all the commercial fishing vessels in the Gulf were likely to carry insurance on Hull. This percentage is about 18.0 per cent on Protection and Indemnity Insurance. Since at the end of 1954 the active vessel population in the Gulf was made up of about 2,040 vessels by applying the above-mentioned percentages and reading from the right-hand scale of Figure 1, you may be able to estimate that no more than 1,020 vessels were likely to carry insurance on Hull and no more than 367

[2]This kind of insurance protects the vessel owner against economic loss which may arise from damages to the hull, machinery, and equipment of the insured vessel under conditions, clauses, and limitations provided by the insurance contract.

[3]Protection afforded under this kind of insurance includes liabilities of the vessel owner arising from damages caused to other property (except collision with other vessels) by the operation of the insured vessel, liabilities arising from personal injuries, illness, or death of captain and crew, and unusual expenses to comply with Government regulations, fines, and penalties, arising because of violation of law under conditions, clauses, and limitations provided by the insurance contract.

vessels on Protection and Indemnity. Every vessel which carries Protection and Indemnity Insurance in the Gulf is likely to also carry Hull Insurance.

2. A Few Observations

How can one explain the situation which the figures indicate? Why do such a limited number of vessels have insurance coverage? Finally, how does this situation affect the insurance problem? So far, our inquiry has disclosed a number of important observations which will be itemized for the sake of brevity.

A. Hull Insurance

First, inability to pay insurance premiums, of course, is the most frequently mentioned reason for noninsurance by the interviewed owners. Actually, had it not been for the fact that banks and other creditors require Hull Insurance on the mortgaged vessels, the number of vessels which carry Hull Insurance in the Gulf may have been much smaller. More than two-thirds of the 63 mortgaged vessels in the sample are insured for Hull. In contrast, no more than one-third of the 162 nonmortgaged vessels are reported to carry the same kind of insurance.

Second, noninsurance is more extensively practiced among fleet operators than one-vessel owners. The former may be financially strong enough to carry part of the risk themselves. Assuming a fleet of 20 vessels with average replacement value of $30,000 per vessel at a 5 per cent rate, the premium paid would be enough to meet the total loss of one vessel or partial losses amounting to $30,000 per year. If such a fleet owner has no insurance on his vessels but puts these premiums aside in a reserve in order to meet total or partial losses against insurable risks on his vessel, this owner is self-insured. A self-insured owner would be able to reduce appreciably the cost of insurance, and may enjoy tax advantages as well.

Third, as far as we were able to determine, self-insurance does not seem to be widely practiced by fleet owners. Noninsurance does not necessarily mean self-insurance unless the owner sets up a reserve to meet damages to his vessel, other than the normal wear and tear, which could have been covered if he carried insurance with a risk carrier. Neither is a depreciation reserve actually a self-insurance plan unless it provides for meeting damages to vessels beyond the normal wear and tear of machinery, equipment, and replacement of old scrapped vessels. One serious limitation of a self-insurance plan is the fact that it does not offer overall coverage. The self-insurance plan in our example does not give protection to the owner of fleet beyond the average maximum of $30,000 per year. Therefore, he should carry excess Hull Insurance with an independent risk carrier in order to have overall coverage. The owner who, for one reason or another, is unable to provide for a self-insurance plan should insure with as high a deductible as he thinks he can bear financially. Noninsurance, however, a practice which seems to be followed by many vessel owners in the Gulf, may sometimes spell economic disaster. Eight of the eighteen interviewed owners who sustained a total loss of their vessel reported that they had no insurance coverage.

B. Protection and Indemnity Insurance

First, the major reason that a very limited number of owners carry P.&I. Insurance can be attributed to the strong ties—family, national, or racial—which exist between vessel owners and crew. About one-third of the sampled owners are captain-owners and one-fourth of the sampled vessels have had

half or more of their officers and crew related to their vessel owner.

Second, for the period 1950-1954, no claims have been reported in the surveyed policy years. Reports of insurance companies and agents in the area indicate that the record has been very satisfactory. Lately, however, the situation seems to be changing. A number of suits are reported to have been filed recently against owners asking for awards for personal injuries of crew members, each representing substantial amounts. As long as provisions of the present legislation are likely to encourage claims by the crew for personal injuries, illness or death without limit, creation of a serious problem is always possible. Such claims are more likely to arise in situations where the crew members and captain have no family, national or racial ties with the vessel owner. Perhaps fear lest such a situation develop in the Gulf may account for the rise in number of vessels carrying Protection and Indemnity Insurance.

As a final observation for both kinds of insurance, the fact that no less than half of the vessels are likely to be noninsured for Hull and no less than 80 per cent to be noninsured for Protection and Indemnity does not diminish the insurance problem in the Gulf. It simply changes its nature, because the risk of economic loss from accidents is always present and the risk from a suit for personal injuries is always possible, irrespective of whether these risks are assumed by a risk carrier or shouldered by the vessel owner himself. Therefore, whether there is insurance or not the need is always present and imperative to find ways and means which will enable the commercial fishing industry to obtain adequate and less costly protection against losses from property damage or against crew claims.

II. SIGNIFICANT DIFFERENCES BETWEEN NONINSURED AND INSURED VESSELS

Are there any significant differences between noninsured and insured vessels? What does a typical noninsured or insured vessel look like?

1. Differences in Hull Characteristics and Crew. On the average, a noninsured vessel is likely to be an older and a smaller vessel in many respects than an insured one. Figure 2 shows that a vessel with no insurance is likely to be about five years older and smaller than an insured vessel by approximately 20 gross tons, 10 net tons, 6 feet in registered length, and 30 horsepower of main engine. On the average, the size of the crew of a noninsured vessel is likely to consist of 2.7 men as compared to 2.9 men of a vessel with insurance.

Other differences, not shown in Figure 2, might also be of interest. About 6 out of every 10 vessels reportedly built or classified under the rules of the American Bureau of Shipping or other classification society are likely to carry insurance. This ratio is less than 4 out of every 10 for noninsured vessels. Very few vessels with motor-gasoline engines were found to carry insurance, while 1 vessel out of every 2 with steam-oil burner was insured. The larger the turnover of captains and engineers employed during 1950-1954 on a vessel, the more likely it is that the vessel is insured.

2. Differences with Regard to Navigation, Communications and Safety Equipment and Value of Vessel. An insured vessel appears to be better equipped than a noninsured vessel. Approximately 2 out of every 3 insured vessels are reported as being equipped with radio-transmitter and/or radio direction finder. The ratio is about 1 out of every 3 for noninsured vessels.

Almost the same ratios prevail on life rings, fire pumps, and medical supplies

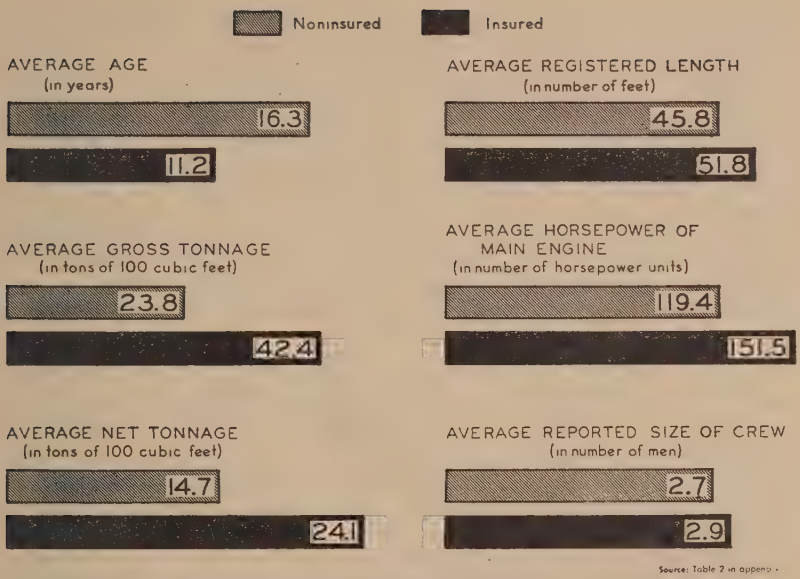

FIGURE 2. Physical characteristics of vessels, Gulf of Mexico fisheries, 1950-1954.

reported by the interviewed owner as being on board the vessel. The exact percentages on these items are shown in Figure 3. More detailed information and additional differences appear in Tables 3 and 4 in the Appendix.

The same Figure 3 shows that the average dollar value of a noninsured vessel is likely to be about one-half of the average dollar value of an insured one. To be more specific, the average original cost of building and equipping a noninsured vessel appears to be 46.0 per cent of the same cost of insured vessels. Similar comparisons can be made of rebuilding cost and current market value relationships. In the former this ratio is 56.0 per cent, the latter 43.0 per cent. Furthermore, the average dollar value of a vessel insured for Protection and Indemnity Insurance was found to be almost three times as large as the average dollar value of a noninsured vessel. More information on this subject is shown in Table 5 in the Appendix.

3. A Few Observations

What do these differences between noninsured and insured vessels suggest? How important are these differences in the evaluation of a commercial fishing vessel as an insurable risk? Evaluation of risks constitutes the basis upon which insurance rates and other terms of the insurance contract are determined, i.e. the basis upon which the cost of insurance is largely based. In view of the importance of this subject, we present a number of observations at this early stage of our analysis.

First, the fact that an insured vessel is likely to be a larger and a better equipped vessel than a noninsured one does not necessarily mean favorable selection of risks on the part of insurance companies. A vessel itself may be a good risk yet noninsured because of financial inability on the part of the

owner to insure his vessel or because the owner is unable to see the need for insurance. On the other hand, a vessel may be insured despite the fact that it is a poor risk. Furthermore, insurance people consider a number of other factors besides the physical characteristics of a vessel in evaluating a risk.

Second, with regard to the physical condition of a vessel, the maintenance record, the fire extinguishing system, and the presence of an automatic pilot rank on top of the list in the underwriting of a vessel. In order to meet the current underwriting requirements of one leading insurance firm in the area a commercial fishing vessel must be hauled for bottom inspection and maintenance repairs twice a year and be inspected four times a year. The same firm would reduce rates to a vessel owner who is willing to install a fixed fire extinguishing system. The reduced premiums would be enough to pay for the expense involved over a two-year period. Since only 11 of the 225 sampled vessels reporting are equipped with such a system, 9 of them insured, one may be able to get some measure of the difference between existing and required safety standards against fire hazard. From the safety viewpoint installation of an automatic pilot constitutes an extra hazard, according to the insurance people in the Gulf. Vessels equipped with such a device may be charged with at least .25 per cent higher than the normal insurance rate.

Third, among the non-physical or qualitative characteristics of vessel operations, seamanship seems to be the outstanding consideration for underwriting purposes. This observation is well substantiated by our findings on the kinds of accidents which we present in the third part of this report. Here, it suffices to reveal that only 4 of the 225 sampled vessels, 2 insured and 2 noninsured, were manned with captains who were licensed to operate a steam or motor vessel of 200 gross tons or more. No engineers were reported having a similar license or certificate.

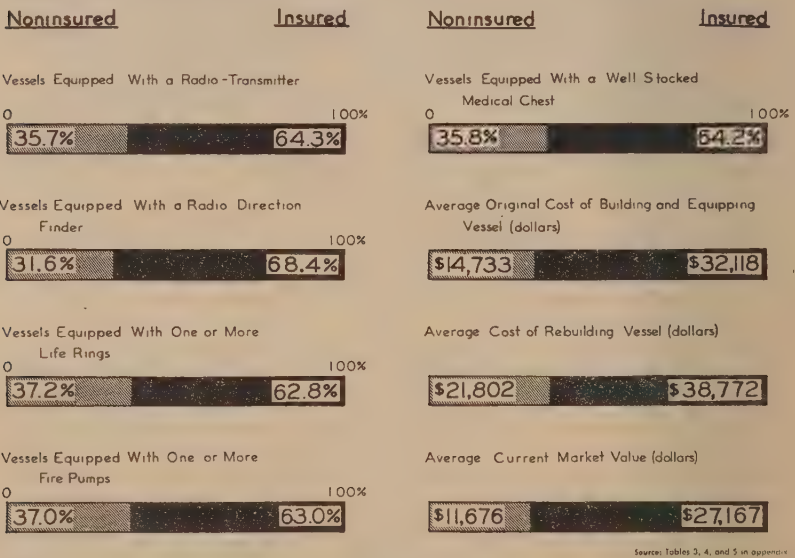

FIGURE 3. Equipment on board and value of vessels, Gulf of Mexico fisheries, 1950-1954.

Fourth, it is the general consensus among insurance people that underwriting commercial fishing vessels nowadays is largely "companionate" or "accommodation" business. One may feel at liberty to question partly the validity of such an argument. However, whatever one's feelings are toward such a contention, the fact remains that, to the extent of this situation prevails, the commercial fishing industry is able to buy insurance which otherwise may not have been available or may have been available but at higher cost. No matter how much established and reputable insurance firms attempt to improve the accident record of the commercial fishing industry by setting up higher underwriting requirements for the prevention and minimization of accidents, their efforts must be confined to their profit consideration. Therefore, beyond establishing high underwriting requirements, risk carriers are apt to be helpness by-standers with the only alternatives to raise insurance rates and/or reduce insurance coverage.

III. COST OF INSURANCE AND ACCIDENT RECORD

Let us now examine the insurance problem from the viewpoint of insurance cost and kinds of accidents.

1. Has the Cost of Insurance Increased Since 1950? Cost of insurance is measured not only in terms of the premium, i.e. the amount paid by a vessel owner for a policy, but also the extent of the coverage he received. Coverage refers to the amount of insurance, the deductible, the franchise, and numerous other provisions of the insurance contract which specify the types of hazards against which the insured vessel owner is protected and the conditions or circumstances under which the insurer is liable. Both the premium paid by the insured vessel owner and the protection guaranteed by the insurer are necessary in order to determine with accuracy the cost of insurance. The numerous possible combinations of these provisions make the insurance contract a highly flexible, legal instrument which enables the insurer to tailor the insurance policy to fit the particulars of each risk. Although some uniformity prevails in practice, differences in the terms of insurance contracts make it difficult, if not impossible, to compare precisely the cost of insurance between risks over time.

Our study takes into consideration both monetary and non-monetary provisions of the insurance contract. However, in our limited analysis here we attempt to answer the question of cost of insurance by comparing the average of net premium with the amount of insurance and deductible for all claims of whatever nature for insured vessels in the sample for the period 1950-1954. This method may be considered as a reliable first approximation.

Averages of net premium, amount of insurance, and deductible for Hull Insurance appear in the left-hand side of Figure 4. Average net premium, i.e. premium paid minus returns, increased from $968 in 1950-51 to $1,161 in 1952-53 and fell to $1,088 in 1954-55. At the same time, average amount of insurance also rose from $19,720 in the first year to $24,175 in 1954-55. The average rate of insurance, which is determined by dividing the net premium by the amount of insurance, rose from 4.9 per cent in 1950-51 to 5.8 per cent in 1952-53. In view of the fact that the average deductible amount also rose from $337 to $402 for the same years, it may be concluded that the cost of insurance was higher in 1952-53 than during the two earlier years. This conclusion coincides with the general experience reported by leading insurance firms in the Gulf. The accident record in the year 1951-52 was reported as unusually high and contributed to the rise in insurance cost in the following year 1952-53. Although the average insurance rate fell to 4.7 per cent in 1953-54 and 4.5 the following year, the average deductible rose to $527 at the end of the period.

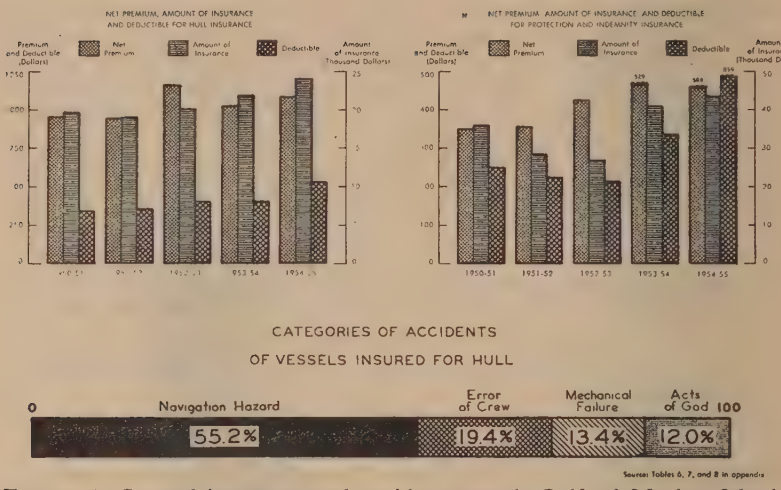

FIGURE 4. Cost of insurance and accident record, Gulf of Mexico fisheries, 1950-1954.

Therefore, it may be concluded that the cost of insurance is not likely to have fallen appreciably below the high level reached in 1952-53. General reports from insurance companies in the Gulf indicate that the cost of insurance is likely to have risen again in 1955-56 because of larger and more frequent claims.

The cost situation for Protection and Indemnity Insurance is shown in the right-hand side of Figure 4. The pattern seems to be similar to the one for Hull. Although the average deductible amount which applies to both personal injuries and property damage fell from $250 at the beginning of the period to $213 in 1952-53, the average insurance rate increased from about 1.0 per cent to 1.59 per cent. Later the average insurance rate fell to 1.17 per cent in 1954-55, but the average deductible increased more than three times to $659. These observations lead to the conclusion that the cost for Protection and Indemnity Insurance apparently rose to a new higher level in 1952-53, which was at least maintained and probably increased in succeeding years. Recent general reports indicate that the cost for Protection and Indemnity Insurance apparently is higher now than in the period studied.

2. Categories of Accidents. Accidents of commercial fishing vessels may be examined with regard to their frequency of occurrence, amount claimed, and the type of hazard they represent. Because of numerous limitations, we are examining here only the general categories of accidents and their probable origin.

At the bottom of Figure 4, a per cent distribution is shown of the number of claims for Hull Insurance for which information has been collected. As much as 55.2 per cent of these accidents fall into the category of navigation hazard, 19.4 per cent are directly attributed to error or negligence of officer personnel and crew, 13.4 per cent to mechanical failure, and 12.0 per cent to weather conditions. It should be noted here that navigation hazard is a general category which seems to be used for accidents which, for one reason or another, are not easily classifiable into other categories. Unfortunately, the in-

surance files examined rarely described in detail the circumstances of this type of accident beyond the typical phrase "struck submerged object," followed by a brief description of the damage to the vessel—usually damage to rudder, propeller, and shaft. In as many as half of the claims examined there is some indication that the reported accident is partly due to inadequate maintenance. General experience reports from insurance companies and agents with intimate knowledge of the situation in the Gulf suggest the conclusion that, barring bad luck which may be present sometimes, navigation hazard is due mainly to inadequate maintenance, poor seamanship, the misuse of an automatic pilot, or a combination of these factors.

3. A Few Observations

A discussion of insurance cost and accident records leads to a number of observations.

First, the available evidence indicates that cost of insuring a vessel for both Hull and Protection and Indemnity Insurance has increased since 1952. Recent reports indicate that the situation is more likely to get worse than better.

Second, long established insurance firms and agencies point out that there is a close relation between accidents and economic conditions in the fishing industry. In periods of slack business activity, maintenance standards are likely to be somewhat relaxed by some vessel owners, resulting in more frequent breakdowns and losses which may increase insurance claims. Their observations, whether accurate or not, will be the subject of further testing on the basis of the collected information. The fact remains that insurance costs may not depend upon accident records alone.

Third, generally speaking, those who insure their property are prone to be negligent and thus may contribute to higher insurance rates. In the case of commercial fishing vessels, therefore, a captain-owner or an owner who has close supervision over the officer personnel and crews of his vessels may have an advantage in self-insurance in addition to the others mentioned previously.

APPENDIX

A Note on Sampling

A variety of sources were used for the collection of information about the subject. Qualitative data were secured through informal interviewing of leading vessel owners in selected ports, fishermen, mortgagee banks, and insurance people. A number of reports, statements, and correspondence related to the subject were consulted. Statistical and other information was collected from existing government and private publications. But the largest body of information was obtained by personal interviewing of a number of owners of a carefully selected sample of commercial fishing vessels and by studying the insurance files of these sampled vessels.

Sampling involved the following major steps.

1. From the annual lists of Merchant Vessels of the United States published by the Bureau of Customs, U. S. Treasury Department, and the records of Fish and Wildlife Service, U. S. Department of the Interior, the statistical universe was obtained of 2,197 commercial fishing vessels of 5 net tons or more which were active as of January 1, 1955, or were lost during the period from January 1, 1950 to January 1, 1955, or were lost during the period from January 1, 1950 to January 1, 1955, and which had as port of registration any port in the Gulf of Mexico (from Key West, Florida, to Brownsville, Texas).

2. This vessel population was stratified on the basis of four variables: (a) active or lost vessels; (b) material, i.e. wood or steel vessels; (c) age; and (d) gross tonnage. The percentages of the stratified universe were used to determine the stratifying quotas for the sample.

3. First-stage sampling involved the selection of the following six home ports with the largest vessel registration: Biloxi, Mississippi; Brownsville, Texas; Corpus Christi, Texas; New Orleans, Louisiana; and Tampa, Florida. Vessel registration in these ports represented 84.8 per cent of the statistical universe. While elimination of nine other ports of registration from final sampling reduced considerably the cost of field work, it was thought that the exclusion of these ports would not affect appreciably the representativeness of the sample. The findings substantiate this contention, since it was found that no less than 49 ports throughout the Gulf of Mexico area were used for fish landings by the 225 sampled vessels.

4. The second-stage or final sampling consisted of drawing a stratified random sample of 225 vessels from the first-stage sample. The size of the final sample was determined on the basis of a formula which provided for a minimum number of vessels, plus an additional number of vessels in the proportion of the vessel population in the Gulf of Mexico to the total vessel population in the continental United States.

5. Although high ownership turnover and mobility of vessel owners during the period under investigation, 1950-1954, made necessary substitution of a number of originally sampled vessels for other vessels from the statistical universe, the representativeness of the sample does not seem to have been impaired significantly. Substitution was done within each stratum and chi-square analysis of the final sample was the known universe by age and gross tonnage has yielded probability values. .50 P .30 and .70 P .50 respectively, which are satisfactory.

6. Sample design provided for the study of 50 per cent of the total number of years the sampled vessels were insured from 1950-1954. The study of insurance files was done on the basis of availability of insurance records among leading insurance agents and firms in the area. Further statistical tests on the reliability of the sample will be made as soon as the processing of the insurance information under progress will permit.

Ways and Means of Stabilizing the Shrimp Market

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FIGURE 1 SHOWS certain basic data on shrimp for the period January 1951 to April, 1956, including:

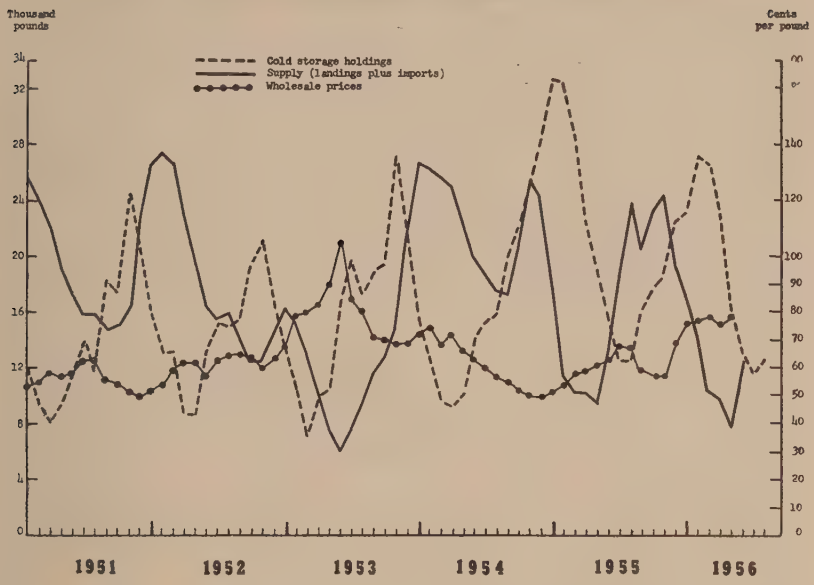
1. Shrimp landings and imports in pounds.
2. Cold storage holdings in pounds.
3. Wholesale prices of shrimp, heads-off (combined for New York, Chicago and Boston) in cents per pound.

This chart shows some relationships which are basic to the shrimp industry and which are basic for the development of our theme.

First, supplies (landings and imports) reach peaks during the months Sep-

Figure 1

SUPPLY (LANDINGS AND IMPORTS), COLD STORAGE HOLDINGS AND WHOLESALE PRICES OF SHRIMP (HEADS OFF, 26-30 COUNT)



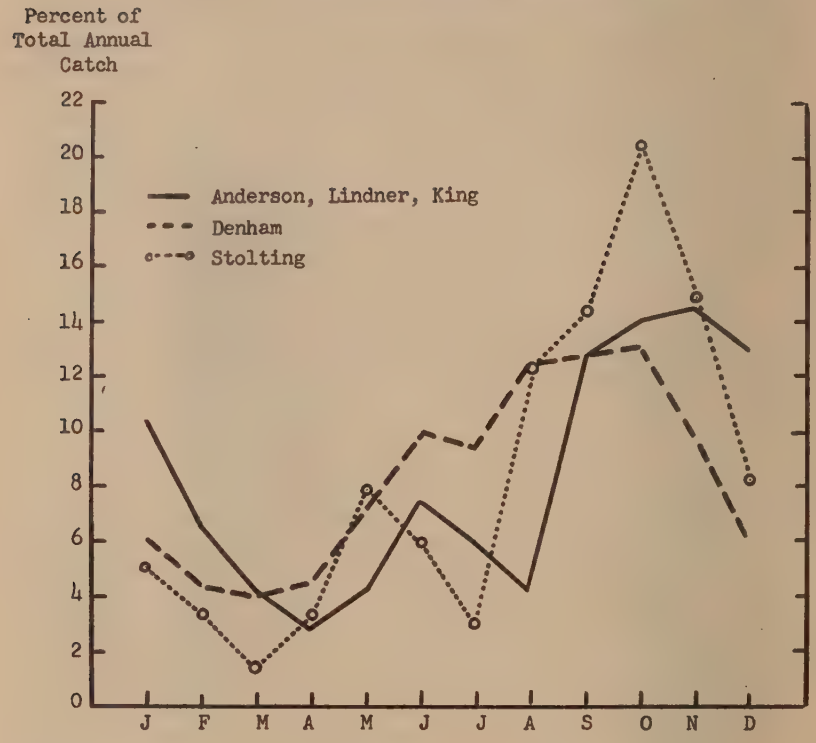
tember to November of each year. Since 1951 these peaks have been at about the same level, namely, 17 to 27 million pounds (heads-off), while lows recur regularly during the months of March to April and always repeat with a certain consistency—between 8 to 11 million pounds per month. Taking landings alone, the peaks amount to 15 to 22 million pounds, and the lows to 5 to 10 million pounds.

This regularity in peaks and valleys of supply were not the same in earlier years, as illustrated by Figure 2.

Again from Figure 1, peak landings are usually followed by peak inventories. In 1951, landings and imports were about 24 million pounds during November. Cold storage inventories at the same time were 22 million pounds, and increased in January, 1952 to 26 million pounds. In 1952, inventories built up only slightly after landings increased; however, in September-October 1953, inventories again followed the trend of supply. In 1954, they increased drastically, due to very low prices at producer and wholesaler level. In 1955, the relationship between landings and inventories returned to normal.

Figure 1 also shows an obvious inverse relationship of supplies and prices. Prices reach a low in October-November and a high in May and June. This fact stands out clearly in 1950, 1951 and 1953. An exception occurred in the year 1954, when prices reached a peak in the month of January, and in 1952 when the peak was reached in the fall. However, the price variations as to seasons are not as intensive as the supply variations. The 1950 wholesale market prices of shrimp (combined prices Chicago, New York and Boston) decreased only about 14 per cent from June to October. In the following year, 1951, they decreased 19 per cent; in 1952, about 5 per cent; in 1953, about 18

MONTHLY SHRIMP LANDINGS AS PERCENT OF ANNUAL CATCH, SELECTED SOURCES AND YEARS



per cent; in 1954, about 17 per cent; and, in 1955, about 16 per cent.

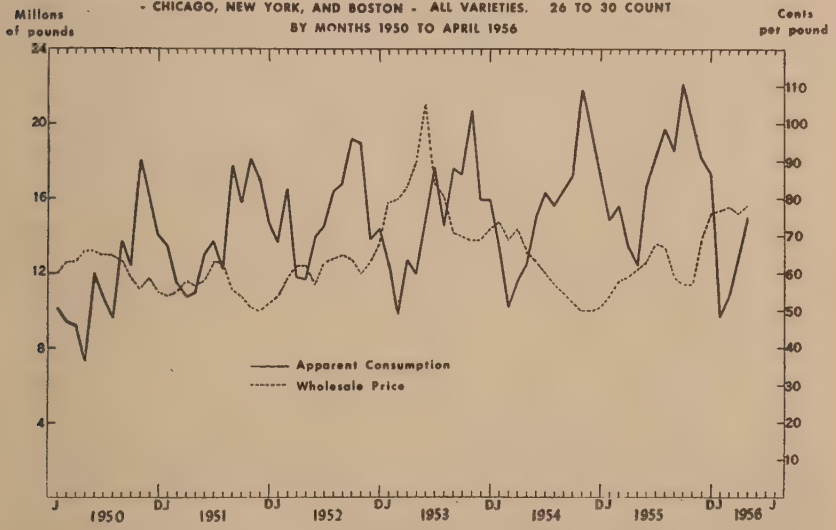
The comparatively small seasonal variations of prices is caused by the influx of shrimp from the cold storage inventories. If inventories had not entered the market during January-June, the June prices would have been much higher. That these inventories have much to do with the price movement can be seen in 1953. When no great inventories were on hand to enter the markets, prices went very high.

Before discussing the actual theme of this paper it will be useful to mention one other characteristic of the shrimp market, the apparent consumption, which is explained in detail on Figure 3. Apparent consumption is the consumption for a certain period of landings, plus imports, plus inventories at the beginning of the given period, minus inventories at the end of the same period, and minus exports. As can be seen from Figure 3, apparent consumption moves with nearly the same variations each year—about 11 million pounds between highs and lows. In 1950 the apparent consumption moved between seven million pounds in April to 18 million pounds in October; while in 1955 the lowest point was 12 million pounds in March, as against 22 million pounds in October. In 1954, the month of lowest consumption was 10 million pounds in February,

as compared to 21 million pounds in October. Apparent consumption by no means is identical with actual consumption; it can be said rather that there is a large variation between apparent consumption and actual consumption. The higher apparent consumption in the month of October is influenced by the great landings which do not necessarily go in the inventories reported by the Fish and Wildlife Service. Many restaurants and retail establishments store, during the months of October-November of each year, great quantities of shrimp which are not reflected in the inventory figures of the Fish and Wildlife Service. Average inventories of shrimp in restaurants are estimated as 3.9 million pounds. Retail stores hold about eight million pounds. Housewives have about 2.2 million pounds canned shrimp on their shelves. It is estimated that about 18 million pounds are held in storage outside the public and private cold storage warehouses reporting regularly to the Fish and Wildlife Service.

Figure 3

APPARENT CONSUMPTION OF SHRIMP AND AVERAGE WHOLESALE MARKET PRICE OF SHRIMP - - CHICAGO, NEW YORK, AND BOSTON - ALL VARIETIES. 26 TO 30 COUNT BY MONTHS 1950 TO APRIL 1956



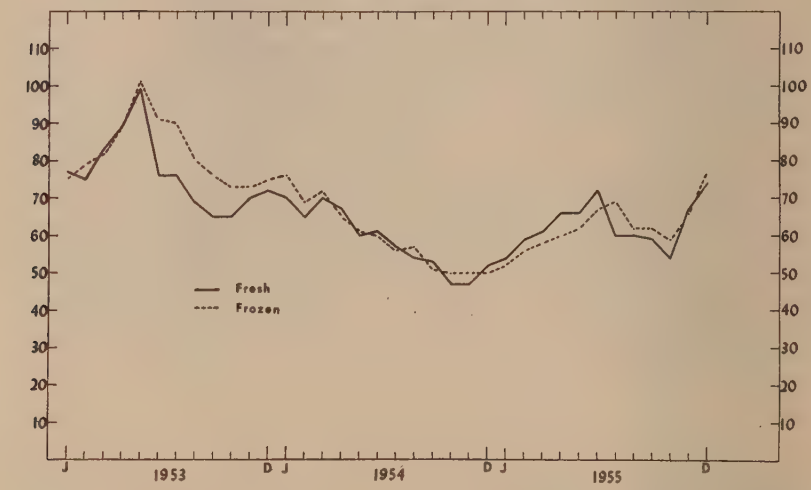
An interesting variation of prices of fresh shrimp and prices of frozen shrimp can be observed in the New York market. As Figure 4 shows, in the beginning of the year fresh shrimp prices are on about an even level, sometimes at a higher level, as compared with frozen shrimp prices. About July and August frozen shrimp prices increase over the level of fresh shrimp prices and remain there nearly to the end of the year. This recurring relationship of prices between fresh and frozen shrimp is due to the fact that frozen shrimp are more readily available for distribution and are welcome for the summer vacation trade. Fresh shrimp gain in their price relationship to frozen shrimp in December, January and February when climate and temperature make easy transportation for fresh shrimp possible and when, at the same time, the

remainders of last year's frozen shrimp are cleaned out to make room for the new crop of frozen shrimp.

Coming to the problem proper, namely, ways and means of stabilizing the shrimp market, we have to consider that the market is mainly based on the three factors which are shown in Figure 1, namely, seasonal variation of supplies, cold storage holdings, and prices. These three factors must be considered in every one of the following sub-titles, namely, (a) Stabilization of the Shrimp Market by General Economic Measures; (b) Stabilizing the Shrimp Market by Specific Measures Adapted for the Shrimp Industry; and (c) Stabilization of the Shrimp Market by Voluntary Self-Help of the Shrimp Industry.

Figure 4

COMPARISON OF WHOLESALE MARKET PRICE OF SHRIMP
26 TO 30 COUNT - FRESH OR FROZEN IN NEW YORK
BY MONTHS - JANUARY 1953 - DECEMBER 1955



Points (a) and (b) may be treated perfunctorily. General economic measures which could be applied are maintenance of employment stability and maintenance of the price level generally, but especially the maintenance of agriculture prices. In this connection reference is made to two charts, one (Figure 5) showing an inter-relation of shrimp prices and the employment of production workers. The two curves on this chart were actually plotted by Dr. Reinhold Wolff of the University of Miami. Figure 6 shows a scatter diagram indicating for each month, January 1952 to May 1955, the prices of fresh shrimp in New York, and the index of employment of production workers in manufacturing industries. It shows that higher employment is followed, or at least accompanied, by higher shrimp prices. Other factors based on specific measures by Government could be limitation of shrimp production by allotment of area of vessels or by Government assistance in the discovery of new shrimp grounds. Government assistance also could be given by the establishment of public cold storage warehouses.

MONTHLY WHOLESALE SHRIMP PRICES, FRESH 26-30 COUNT, ALL VARIETIES, NEW YORK
VS.
TOTAL NUMBER OF PRODUCTION WORKERS IN MANUFACTURING INDUSTRIES, U. S.
1952-1955

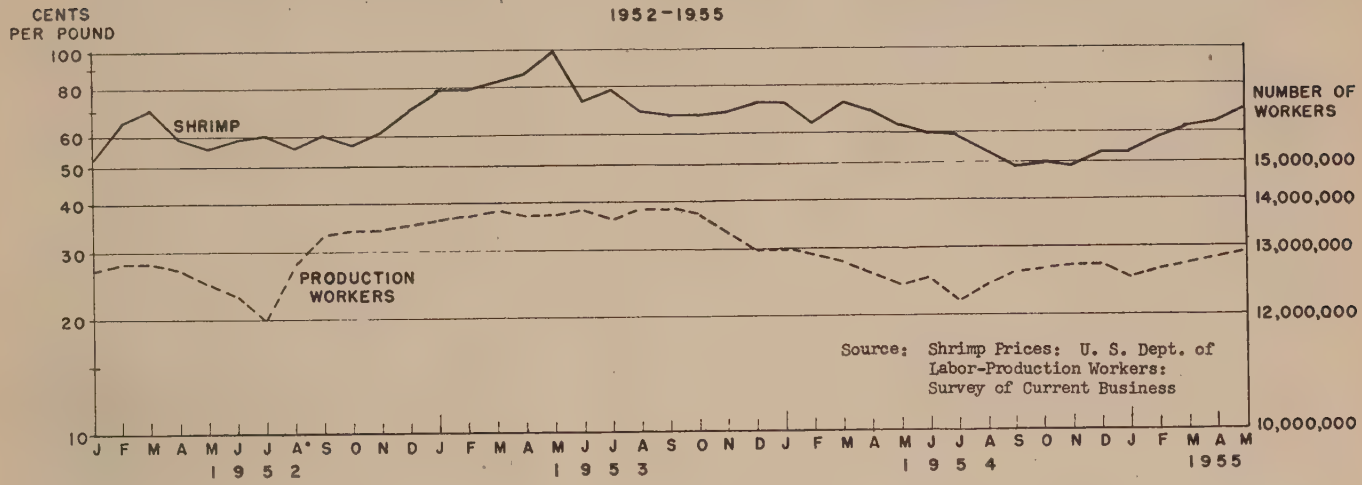
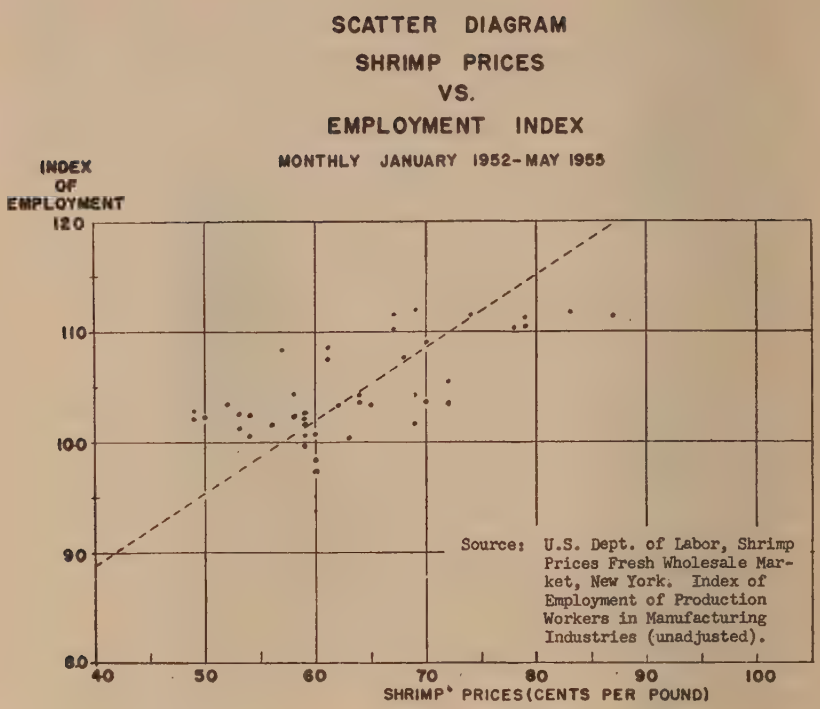


Figure 6



Of the international measures which could be applied to stabilize the shrimp market, tariffs and quotas are well known and need not be discussed in this connection. International agencies such as the United Nations recommend against instability—Buffer Stocks and Contracyclical Lending. The possible governmental measures are mentioned only by name without going into details because in countries where the free enterprise system prevails governmental measures of any kind are considered of only a subsidiary character.

The following discussion will deal in greater detail with stabilization of the shrimp market by voluntary self-help of the shrimp industry.

What can the shrimp industry do itself to stabilize the market?

On the negative side, the industry has, from time to time, had to face factors over which it has no control. Such factors are natural contingencies, such as storms, which hardly can be overcome by human interference. Deficiencies in production in agriculture caused by natural adversities are sometimes balanced by crop insurance and this is a successful device in this industry. It will be possible to extend to the fishery industries, including the shrimp industry, a type of catch insurance only when more experience is gained by observing greater time periods of production and prices. We have had only about eleven years of constant observation of shrimp prices and such a period is not enough on which to base an insurance system.

Apart from natural factors, stabilization of the market depends on production increasing proportionately with increasing population or with constant costs of production. If domestic production cannot fill the needs of increasing domestic consumption, imports from foreign countries, either on American vessels or on foreign vessels, may be necessary. Domestically sponsored exploratory fishing may assist to keep the supply on an even level; such exploratory fishing can be undertaken by private firms, by corporations or by associations, as well as by the Government.

Influx from cold storage warehouses is periodically necessary, as we have seen in Figure 1, to bring production plus imports to levels that balance the increasing demand. If there should occur a decrease of consumption by unexpected shifts in taste or income or change in the birth rate, promotional campaigns may do much to stabilize sales and prices. A recent study undertaken by the A. C. Nielson Company of Chicago, on the basis of a Saltonstall-Kennedy contract, shows that more complete stocking of shrimp products and package sizes in retail stores had as a consequence an increase of about 60 per cent in bi-weekly sales. Point of sales advertising in addition was responsible for another increase of 14 per cent.

Fishermen often make a mistake in continuing to produce through "thick and thin." That means, regardless of a market drop or a drop in the price level the fishermen continue to produce only the product in which they specialize. Fishermen will be able to cope better with depressions when they have multi-purpose vessels and varied production.

It is also observed that, during a decline of prices, fishermen often fail to cut the variable costs of production, which are mainly composed of oil, gasoline, ice, wages and repairs. Price margins between producers, wholesalers and retailers are, to a large degree, inflexible. A decrease in the retail price will consequently have the greatest effect on the price of the producer. The fisherman must then reduce his cost, until such time arrives when there is a greater demand and a higher price.

Economists agree on one point important to the shrimp industry. Consumers have become less sensitive to changes of relative prices of foods since they have more proprietory funds to change over from one product to another. With the development of technology all nations are becoming wealthier, and therefore a relatively good price for shrimp can be expected even if competing foods show greater changes in their price behavior.

The last item of how the industry can help to stabilize the shrimp market is future trading. The characteristic of future trading is to shift the risks from one's own enterprise to others. Such future trading is common in a number of staple commodities whose prices fluctuate greatly.

A future contract may be defined as an agreement on the part of the seller to deliver, and of the buyer to receive and pay a certain price for a certain kind and quality of the commodity at some specified future time, under conditions prescribed by an exchange or understood by the trade. Dealing in futures is necessarily connected with established commodity exchanges. Trading on the commodity exchanges is usually made up of two classes of transactions—spot or cash transactions. Cash sales are mostly based on samples, while future contracts are mostly based on grades which are determined in advance.

It is generally recognized that some prerequisites are necessary for a commodity to qualify for future trading on an exchange. One is homogeneity. This

means, the product must be so standardized that the various units are conveniently interchangeable. It is essential for future trading that commodities be graded. Up to now, standards and grades for shrimp products have not been established, but some work is being done to establish grades for breaded shrimp and it is hoped more progress will be made. Standards and grades for breaded shrimp should be followed by standards for frozen headless shrimp and eventually for frozen cooked and peeled shrimp.

Second, the commodity must have a minimum degree of perishability to permit storage for future delivery without appreciable deterioration. Third, there must be an adequate amount of the actual commodity available from year to year at the point where the future market is established.

Finally, a large volume of trading is desirable. Naturally, in the case of shrimp we do not have as great quantities available as in the case of grain, rubber or potatoes. However, there are exchanges existing on products which are available in smaller quantities than shrimp, for example, certain metals or certain agricultural products, as tea and pepper. Some canned vegetables also are handled in commodity markets.

The main advantage of the future markets for general market stabilization lies in hedging. Hedging may be defined as the practice of entering simultaneously into two contracts of an opposite nature, one the spot market, one in the future market. One contract involves a purchase, the other a sale. The only common factor is the amount of the merchandise.

Federal legislation regulates commodity markets on agricultural products. It mentions the dangers of future trading if such trade is used for speculation, manipulation or undue control by persons handling the commodities. The legislation provides for an inspection of the dealings of commodity exchanges, for a certain limitation of hedging transactions, and the prohibition of fraudulent acts. It establishes the right for the Secretary of Agriculture to exclude from the commodity exchanges persons of doubtful character. Futures commission merchants have to be registered by the Department of Agriculture and registration can be revoked or suspended.

Since shrimp (or any other fishery products) are not mentioned among the commodities which are regulated under the commodity exchange act such fishery commodities can be introduced in exchanges which are based on mere State legislation. If the industry feels that the time has come to extend futures contracts to fishery products, State legislation may serve that purpose, for example, for shrimp in Texas or Florida or for fish fillets in Massachusetts. Possibly the Department of the Interior can assist the industry in this connection.

But, even if the industry develops futures contracts on shrimp and a commodity exchange to handle such contracts, the basis of the commodity exchange activities will always be the following factors: (a) statistics; (b) economic forecasts; (c) Governmental policies. These three can be brought together by information. A good information system on statistics, on forecasts and on policies is important in any futures trade. The Fish and Wildlife Service attempts to give information by statistical reports, outlook reports and market news services. Improving these reports and willingness of the trade to use these reports are the real basis of the stabilization of the shrimp market.

In summary, there is no absolute panacea for stability of the shrimp market.

The medicine which the industry may apply to stabilize the market is composed of many ingredients. Some of the ingredients have to be obtained from the outside and some of the ingredients can be developed within the industry. From the outside come (a) constant employment; (b) balanced price level and (c) even flow of credit; from the inside come (a) balanced production; (b) loans on inventories; (c) maintenance of quality; (d) adjustments of costs to business variations including costs of advertising; (e) multi-purpose fishing and (f) futures trading. In former years the meetings of the Gulf and Caribbean Fisheries Institute gave opportunity to discuss many of the ingredients in greater details. Only one is newly mentioned to date. It is the introduction of shrimp into commodity markets and the establishment of futures trades on shrimp.

A Summary of Studies on the Marketing of Florida Fish

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Abstract

Segments of Florida's fin fisheries have suffered depression since 1952, when there was a decrease in the demand for mullet, the principal food fish produced.

Factors contributing to the decrease in demand for mullet are: (1) increased competition from other seafoods, meat and other protein items; and (2) changes in food marketing techniques as exemplified by the growth of the super market and the increase in packaged frozen fishery products.

Restrictive legislation and the failure of the Florida industry to take advantage of recent developments made in the fishing industry are contributing factors to the decline in the demand for mullet and other Florida fishery products.

It is recommended:

1. That problems of competition from imported fishery products on the marketing of southern species be examined.

2. The impact of transportation rates on sales of southern species be investigated.

3. That a rigorous and continuous public relations campaign be conducted to improve the public sentiment toward commercial fishing.

4. That strong emphasis be applied to improving the quality of fishery products. Experience has shown that, left to itself, the industry has been slow in improving quality. Therefore, some enforceable regulations may be necessary to improve sanitary laws applying to fish houses, and quality standards applying to the product.

5. That efforts be made to develop new products, to take advantage of the trends in marketing fish. Possible new products include: smoked mullet, headed and gutted mullet, mullet fillets, canned mullet and fish sticks.

6. That a vigorous and continuous advertising and promotion campaign be conducted to increase sales of southern sea foods.

Fish Consumption—Where is it Headed?

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The consumption of edible fishery products in the United States is now about 10 pounds per capita per year on an edible weight basis. For a number of years the per capita consumption has remained close to this figure. What the figure is apt to be some years in the future is impossible to forecast with any accuracy. However, a good many predictions are being made about conditions which will prevail in the United States about 20 years from now—that is, in 1975. The assumptions economists have made in this connection—and projecting some of the present trends in our economy—provide a basis for discussing probable future fish consumption.

Because 1975 is almost a score of years away and a good many variable and unknown factors are involved, the chances of an accurate evaluation are not too high. Nevertheless, it should be of interest to mention those current and future developments which may be expected to affect the consumption of fishery products, even if we cannot reach a conclusion as to the eventual outcome.

Since it is not possible to assess the exact importance of the factors which influence fish consumption no attempt will be made to discuss them in any particular order.

Population, however, is usually one of the first items to be discussed. In 1975, the United States will have about 220 million people, or roughly about one-third more than now. If recent trends continue, an increase in population will require a corresponding increase in domestic production or imports, but will not, of itself, increase or decrease per capita consumption. However, the changed distribution and composition of this population could have such an effect.

For example, people are moving from farms to urban areas. Our surveys show that fish consumption is less in farming areas than in urban areas, so this is a favorable trend if those who move adopt urban customs. More people are moving to the West, the Mountain States, and the South, with the new industries being established there. Coastal Western states have a relatively high fish consumption rate, so again this should be favorable. On the other hand, the South and the Mountain States consume less fish than other areas. However, in this instance we might hope that the newcomers from greater fish-consuming areas would indoctrinate the Southerners and the Mountaineers with their fish consuming habits.

We also find that our increased population will have relatively more young people from 10 to 20, and more elderly people over 65. From a dietary standpoint, fish is excellently suited to the needs of elderly people because vitamins, minerals, proteins and fat may be obtained in fishery products almost in any degree desired. Thus, fish consumption would be expected to hold its own or increase in this group and thereby favorably affect overall consumption.

Fish consumption has increased in those schools where fish cookery has been demonstrated by Fish and Wildlife Service personnel to the school lunch supervisors. With more young people available in schools, we can expect consumption to continue to increase in this group—until all schools have had

demonstrations of the merits of fish—and of course, again to affect favorably the total consumption.

With the increase in population will come a substantial growth in our economy. The Gross National Product—worth about 410 billions of dollars this year—is expected to almost double by 1975. And an increase of well over 50 per cent in the real income per person will accompany it. Experience and surveys have shown that an increase in income does not increase per capita consumption of food products much, if any, simply because human stomachs can hold only a certain amount. However, there are shifts among foods. Generally, more of the higher priced foods are purchased, more luxury items, and more of the foods which are so advanced in preparation that they are ready to eat with little further work—foods with "built-in maid service." And there may be larger purchases of protein foods and those abundantly supplied with minerals and vitamins. Fortunately, fish of one sort or another can meet all of these demands. Therefore, fish consumption should not decrease, as for example, consumption of cereals and potatoes have. It may be expected to gain slightly, or perhaps substantially, because of the wide ranges available in price, processing and composition.

An increase in real income indicates higher living standards. People as a whole also are expected to be better educated. They will, therefore, be more discriminating in their purchases, especially with regard to qualities and values. No doubt fish can compete in value but much needs to be done to eliminate the danger of decreased consumption arising from the lack of the highest standards of quality.

The next 20 years will see important changes in the labor force. Already over one-half of our female workers—58.7 per cent in April 1955—are married and the proportion is expected to rise. Undoubtedly this means a shift to food products which can be made ready for the table in a minimum of time with a minimum of effort. But it also may mean a shift in consumer habits, especially for families without small children. More meals may be eaten away from home because of the wife's greater income and the shorter time she has for preparing food. The wide variety of quickly prepared consumer products already available indicates that the fishing industry is flexible enough to meet any challenge in this field.

And the adaptability of fishery products to the portion control now exercised by most eating places, together with the fact that public eating places make as much or more profit from serving fish as from serving meat and poultry products, suggests that fish consumption should not suffer whether meals are eaten at home or away.

It is more difficult to assess what effect more leisure time will have on fish consumption. The work week, now averaging about 40 hours, is expected to drop to 35 hours in 1975 and it is forecast that people will retire at an earlier age. More leisure could mean more time to choose and prepare foods, or more time and meals away from home. Presumably fish consumption would not be materially affected in either case because of the adaptability of fish processing to either situation.

By 1975 automation will be commonplace, not only in factories, but in offices and laboratories as well. More use of machines means less physical exertion and a greater demand for foods high in proteins, minerals and vitamins. Since fish can supply these demands increased automation may be expected to maintain and possibly increase fish consumption.

Along with automation will come other drives throughout all industry, each aimed at securing a competitive advantage with regard to production costs and selling prices, or variety, uniqueness, and quality of products. If we can assume that fish is reasonably competitive in these factors now there is every reason to believe it can remain competitive and thus maintain fish consumption levels. There are even factors which indicate that our fisheries could become more competitive with other food products and, as a result increase fish consumption.

If we take production costs, for example, there are great opportunities to mechanize fishing operations and place them on a large scale production basis. Competition, and interest in survival, if nothing else, should force the use of the most efficient gear and the operation of functionally designed vessels. Probably this will develop under fishery management programs which will eliminate those legal limitations which now often force the fishing industry to use outdated methods and equipment while competitive food producers—agriculture, for example—have almost revolutionized their procedures by immediately adopting every progressive development.

Of unknown, but probably of the very greatest importance to cutting production costs are the untouched fishery resources and the unexplored areas the industry may be able to draw upon to whatever degree needed.

Since 1949 there has been a steady increase in the proportion of imported edible fishery products contributing to our total domestic consumption. There is every reason to believe that the percentage—which was 19.7 in 1949 and 35.4 in 1955—will continue to rise, but probably not as sharply. Foreign fisheries have been developing rapidly and show no particular signs of halting their expansion. And many of these fisheries are expected to continue to aim a substantial part of their production at the United States market until prices, demand, and processing and distributing facilities, especially for frozen fish, become more comparable in other countries. Consumption per capita of all fishery products should not be affected materially by a greater proportion of imported products unless drastic price increases or decreases occur, and these are not expected to materialize. Only a new processing technique, a new product, or some similar advantage could alter this probability.

Exports of fishery products from the United States to other countries have been declining steadily. There seems little chance of an increase in exports so substantial that the volume would materially decrease overall domestic consumption. This presupposes no wars or police actions, since such developments usually decrease consumption and alter trade patterns, especially for canned fish.

The consumption of fish is directly affected by the price and demand for agricultural foods, such as meat, poultry products, and dairy products. This being the case, it is of some interest to examine per capita consumption figures for these foods as projected to 1975 by the U. S. Department of Agriculture. In a recent publication we find that the "food consumption per person" as indicated by the Agricultural Marketing Service Index would be expected to increase about 12 per cent from 1953 to 1975. This sounds bad for fish consumption until we learn that the index involves a price factor. Thus, the consumption increases reflect mostly a continued shift to higher unit-cost foods and away from cereals and potatoes. The pounds of food and calories consumed per person are expected to change only a little but some increases in proteins, minerals and other requirements of an improved diet are expected.

Examination of a tabulation of the projected per capita consumption of cer-

tain livestock products in the same publication revealed a projected increase in meat consumption of 11.8 pounds from 161.2 pounds (carcass weight) in 1955 to 173.0 pounds in 1975, or seven per cent. Chickens and turkeys were expected to increase from 25.9 pounds (eviscerated weight) per person in 1955 to 32.2 pounds in 1975, or 24 per cent. During the same period egg consumption was expected to jump from 366 per person to 403, or 10 per cent. Cheese consumption would increase moderately from 7.7 to 8.0 pounds, or four per cent, as part of an increase in the consumption of dairy products (fat solids basis) from 700 to 720 pounds, or three per cent.

Of other products the consumption of food oils is expected to increase very little. Fruit consumption will increase about 19 per cent, and consumption of tomatoes and leafy, green and yellow vegetables about 16 per cent. Potatoes will drop from 101 to 85 pounds, or 16 per cent. Dry beans and peas, grain products and sugar are other foods which are expected to be consumed in lesser quantities.

The projected increases in meat, poultry and milk consumption suggested an inquiry of the author of the publication to determine if the tabulation actually meant that these competitors of fishery products were expected to make these gains at the expense of fish. It appears that this is not the case. The projection is based, to a considerable extent, on the expectation that a larger proportion of the population in 1975 will be younger people who are relatively heavier eaters. It was estimated that, at the most, only a two per cent increase in per capita consumption might be ascribed to the average individual increasing his food intake. Presumably, the factors inducing this slight increase would also apply equally to fish consumption, so it may be concluded that its relationship to the consumption of competitive agricultural foods will not be impaired.

No doubt there are many other factors which may affect future fish consumption. In the handling and processing of food products we are on the verge of expanded use of antibiotics and radiation preservation. Certainly, fish seem well adapted to antibiotic treatment after catching and should share whatever advantage competitive foods might gain through use of this technique.

Radiation preservation of foods is still in the experimental stages but being pressed vigorously. To date tests with most fishery products have not been especially successful insofar as long-term storage is concerned. Radiation pasteurization which will increase storage life for a limited period is now being tested and may prove more desirable. The very great interest of the Army in radiation preservation and the results of tests carried out to date indicate this process probably is going to become very significant in the future. Its possibilities are tremendous if its potential advantages in regard to decreased processing and storage costs, simplified packaging, improved quality, etc., are achieved. We see no reason, at present, why most fishery products should not be as well adapted to use of this process as competitive foods. If they are not, the consumption of fish could decline appreciably.

One other shadow lies over fish consumption in the future. At present, we use over 40 per cent of the catch for non-edible purposes—mostly for fish meal and fish oil. Neither of these products are of such value as to divert much more substantial quantities of edible fish to non-edible uses than are used at present. This does not mean, however, that much more valuable pharmaceutical or industrial products might not be derived from fish. These could be products so valuable that they might create an industrial technology based on fish, much as similar technologies are based on petroleum and coal as basic raw materials.

With the expanded research on fish now underway, the possibilities are not as extreme as they may appear. A case in point is the potential use of fish oil sprays to control insects, funguses, and nematodes. Research sponsored by the Service with Saltonstall-Kennedy funds has indicated the unique value of fish oils in these fields. Modified fish oils apparently are 32 times as effective on citrus trees as presently used fungicides. If widely used, more fish oil than currently produced would be required to meet the demand for fungicides and insecticides. And if used to control nematodes in the roots of citrus trees a similar additional amount would be required. This represents only one of many promising developments in the industrial and pharmaceutical field.

While it is impossible to weigh accurately the probable gains or losses in the consumption of fish for edible purposes in the next 20 years it appears that any change either way probably will not be very significant. That is, not unless the industry takes the fullest advantage of its opportunity to exploit to the utmost the variety and nutritive value of fish, and to present consumers with a product whose quality is unsurpassed. Should this occur fish consumption could increase considerably.

Even so, we may see most of the cheap and abundant fish become so valuable as a raw material for industrial use that the remaining varieties will become luxury food items with a significantly diminished overall per capita consumption.

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The New Place of Commercial Fisheries in the United States Government

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ON AUGUST 8, 1956 the joint efforts of the commercial fishing industry of the United States, wildlife conservation groups, the Congress, and the Executive Branch of the Government culminated in the signing of Senate Bill 3275 by President Eisenhower. His action transformed the bill into Public Law 1024 — 84th Congress, 2nd Session — or, as it is more popularly known — The Fish and Wildlife Act of 1956.

It is generally conceded that the Act represents a significant forward step in commercial fisheries legislation because, for the first time, the fishery resources are specifically recognized as making material contributions to the national economy and the well being of the Nation's citizens.

The Act then goes on to declare a fisheries policy, to outline future programs and activities, and finally, to provide means for carrying out these programs and otherwise aiding the commercial fisheries.

Properly administered, these provisions of the Act appear adequate to permit the appropriate amount of deserved Federal assistance required to help solve those problems which brought about the introduction and enactment of the legislation.

Time — and the manner in which the authority under the Act is exercised — will determine if this conclusion is correct.

The Act, as its title indicates, concerns both "fish" and "wildlife." For the purpose of this review, however, I shall refer hereafter only to those provisions of the Act as they relate to commercial fisheries.

The Act begins with a Congressional policy statement which stresses the important place of fishery resources in the national economy. It spells out as among the fundamental needs of the fishing industry first, Freedom of Enterprise, second, Protection of Opportunity, and third, Governmental Assistance.

Under the latter category it specifies that Federal aid should be consistent with that provided industry generally and includes such items as:

(a) services to provide current information on production and trade, market promotion and development, and an extension service,

(b) research services for economic and technological development and resource conservation, and

(c) resource management to assure the maximum sustainable production for the fisheries.

This Congressional statement represents an important advance in clarifying the position of fishery resources in the national picture, and in defining what the fishing industry may rightfully expect from the Congress. Together with the following sections of the Act, it strengthens immeasurably the position of the Department of the Interior as the primary agency for, or a responsible participant in, all governmental fishery matters.

A very important section of the Act — Section 5 — is headed INVESTIGATIONS, INFORMATION, REPORTS. Its significance lies in the fact that it requires

the conduct of continuing investigations, the preparation and dissemination of information, and the making of periodical reports to the Public, the President, and to the Congress on certain specific matters and also on any additional matters of public interest in connection with fisheries.

The matters to be investigated and reported upon cover the entire commercial fisheries field. I will mention them as they are listed in Section 5 with brief comments as to the status of our current programs in these fields. This will indicate the substantial program changes required by the Act.

The first investigation and report is required on the production and flow to market of domestic and competitive foreign fish and fishery products.

Reasonable compliance with this directive would require considerable expansion of a number of the Service's statistical and economic projects and initiation of some new ones.

The second investigation and report is required on the availability, abundance and biological requirements of the fishery resources.

The commercial potential of our resources, the best means of reducing them to possession, and recommended optimum utilization. Measures now are being determined by exploratory fishing and biological studies on a demand or spot basis.

This directive requires that we must proceed with at least deliberate speed, toward a more complete inventory of fishery resources within domestic reach; determine the best means of catching the fish making up the resources; and study and recommend measures to preserve the resources for perpetual use at the most appropriate level.

The third investigation and report is required on the competitive economic position of fish and fishery products with each other and with competitive domestic and foreign commodities.

This directive requires studies of domestic and foreign fishery products approximately comparable to the research conducted on agricultural products.

The data required as a basis for the studies indicated now are available only in part. Expansion of domestic statistical and market news data, outlook reporting, and foreign production and marketing information would be a primary need.

Various production, price and distribution indexes must be begun or further developed if trends and competitive relationships are to be determined. Tariffs and trade agreements must undergo a more detailed analysis. Parity price series must be extended to all important fisheries. Gross, net, and per capita income studies become a necessity, as does research on profits and capital investment. Output information is required, and, possibly, "market basket" studies to determine the percentage return to all who handle fishery products. And, finally, all data relating to the position of competitive domestic agricultural products must be analyzed.

The fourth investigation and report is required on the collection and dissemination of statistics on commercial and sport fishing.

Our commercial fishery statistics have become much more comprehensive in recent years. However, the coverage, whether by area, commodity or function, is not fully adequate and the dissemination, especially with respect to timeliness, must be improved upon.

Sport fishing statistics are practically nonexistent except for sporadic surveys.

In view of the uncertain magnitude of the sport fish catch initiation of surveys in this field will be very useful.

The fifth investigation and report is required on improved production and marketing practices in regard to commercial species and the conduct of educational and extension services relative to commercial fisheries matters.

There is no fishery information or extension service as such but there is a very great need for filling the gap. The fishing industry definitely suffers from a lack of ready access to improved fishing, handling, processing, and marketing techniques. It is generally recognized that fishery research achievements in these fields are farther ahead of their adoption by the industry than is the case in agriculture or comparable businesses. Nor are statistical, market news and economic services used to their utmost.

Educational activities at the college and vocational level have received a much needed stimulus from the enactment of Public Law 1027. This Act authorizes the appropriation of $550,000 to the Department of the Interior for grants to universities and colleges to promote the education and training of professionally trained personnel needed in commercial fishing, and $375,000 to the Department of Health, Education and Welfare for vocational training in the fishery trades.

Appropriation of these sums during the next fiscal year will provide the means for training the personnel required to help maintain the domestic fishing industry at the important level in the national economy that the Congress has proclaimed for it. These personnel are essential, directly or indirectly, to the research, the services and the other activities required or contemplated under the Fish and Wildlife Act of 1956.

The sixth and final investigation and report is required on any other matters of public interest in connection with any phase of commercial fisheries operations.

This directive simply insures that there shall be no lack of authority to investigate or report upon any other matter affecting the commercial fisheries.

Section 7 of the Act is headed POLICIES, PROCEDURES, RECOMMENDATIONS. This section requires the Department to consider and determine the policies required to carry out, in the public interest, the laws relating to commercial fisheries. The Department also must develop measures and activities, conduct studies, take steps, and make recommendations with regard to specific fishery situations.

In general, Section 7 builds on the continuing fishery investigations discussed under Section 5, requiring that measures be recommended and steps be taken to assure desirable, or prevent undesirable, developments.

The specific duties under this section are as follows:

First, the Department must develop and recommend measures to assure maximum sustainable production of fish and fishery products and prevent fluctuations.

The recommendations required presumably would be made to States, Territories, International Fishery Commissions, and the domestic industry.

They should be based on more adequate biological studies and exploratory fishing of our resources, and on expanded gear development and vessel design. Technological development of improved practices and new products, and probably economic surveys also play a part.

Second, the Department must study the economic condition of the industry, and make recommendations to the President and the Congress for stabilizing

the fisheries if there have been fluctuations in abundance or unstable marketing or fishing conditions.

The recommendations directed to the President and the Congress should be based on more adequate statistical data, and market news reports than are now available. And additional spot and long range economic studies are desirable. The recommendations could be of a legislative character or suggest the use of other administrative powers or means to meet the situation.

Third, the Department must develop and recommend promotional and informational activities to stimulate consumption whenever there is a prospective or actual surplus.

These recommendations would be directed to other Federal agencies who might assist the domestic industry, and to trade and other organizations of the type whose members use fishery products in appreciable quantity.

These recommendations should be based on timely and reliable statistical data confirming the existence of surpluses, and on a market development program comprehensive enough to coordinate a consumption campaign on a national scale.

Finally, the Department must take steps to develop, advance, manage, conserve and protect the fishery resources.

This requirement is closely allied to the first directive which required the development and recommendation of measures to assure maximum production and prevent fluctuations. The two differ in that the former provides for recommendations only, while the latter requires that positive steps be taken toward the specific goals of resource management and protection.

Section 8 of the Act is entitled STATE DEPARTMENT—COOPERATION. This section prescribes that the Department of the Interior shall be represented at international conferences, consulted on foreign aid programs, and represented in tariff negotiations whenever fishery interests are involved.

Periodic Departmental consultations on fishery problems also are required with governmental and other organizations.

In general, Section 8 confirms the Department's position as the Federal policy-making and service agency for fish and wildlife in both the international and domestic fields, subject, of course, to overriding national interests.

The President has stated that it is, and has been, Administration policy to utilize the resources of the Department of the Interior to formulate United States policies affecting fishery matters of international concern.

The reference to periodical consultations with other agencies and organizations indicates that the Department is to take the lead in seeking cooperative solutions to fishery problems as well as to utilize the advice and services of agencies in the same or allied fields.

Section 9 is entitled REPORTS ON ACTIVITIES AND IMPORTS. In general, the section strengthens the Department's position as the Federal policy-making and service agency for fish and wildlife, by requiring an annual activity report plus recommendations for necessary legislation. In addition, the Congress looks to the Department for voluntary reports on imported fishery products as problems arise, and suggests that the Tariff Commission request a report from the Department of the Interior as a part of its investigations under certain tariff acts. Finally, it directs the industry to ask the Department to report on imported fishery products, upon industry request, when there has been downward trends in domestic production or sales or increases in imports.

The voluntary departmental reports are a new responsibility, or at least one that has not been exercised previously.

The report by request of the Tariff Commission has not been spelled out explicitly before, but the Commission has been in close touch with the Fish and Wildlife Service on fishery tariff matters and makes considerable use of Service data.

The report on the import situation by request of an affected industry segment is a new responsibility which needs a great deal of study since other agencies have similar responsibilities.

The several sections of the Act I have mentioned both confirm present departmental responsibilities and add a number of important new duties.

Other sections of the bill provide for measures to assist in carrying out these old and new activities.

For example, Section 3 provides for a strong fisheries administration in the Department by establishing a new Assistant Secretary for Fish and Wildlife, and a Commissioner of Fish and Wildlife. For the first time in our history an Assistant Secretary will devote his full time and energy in the interests of commercial fisheries and wildlife. A new United States Fish and Wildlife Service has been established which consists of two separate agencies, each with the status of a Federal Bureau. The functions of the new United States Fish and Wildlife Service will be administered under the supervision of the Commissioner of Fish and Wildlife, subject to the supervision of the Assistant Secretary for Fish and Wildlife. The two separate agencies, known as the "Bureau of Commercial Fisheries" and the "Bureau of Sport Fisheries and Wildlife", are headed by Directors. The Bureau of Commercial Fisheries is responsible for those matters relating primarily to commercial fisheries, whales, seals, sea-lions and related matters.

Section 6 of the Act provides for the centralization and coordination of fishery programs now in other governmental agencies by requiring a review and possible transfer of the fishery functions of these other agencies to the Department of the Interior.

Section 4 of the Act establishes a $10,000,000 fisheries loan fund to make loans to fishing vessels and for fishing gear, and for research into the basic problems of fisheries. The availability of these funds to make loans to those in the industry who are unable to obtain loans on reasonable terms elsewhere is expected to ease a serious credit situation in several areas.

As a final aid, both to the industry and to the Department's research and service programs, the Act makes permanent the Saltonstall-Kennedy Act, which was to terminate on June 30, 1957. Extension of this Act not only permits continued research and services for the industry but also increases the sums available from $3,000,000 to well over $4,000,000 annually.

Thus, the Act, while requiring a great deal of expanded effort on the part of the Department also has provided the tools with which to accomplish the work.

Although we are just beginning to operate under the Act there is every reason to believe that the new organization with its greater responsibilities, its increased funds and its improved position will render improved service to the Nation's important commercial fisheries.

DISCUSSION

Economic Session

Discussion Leader: Francis Taylor

Discussion Panel: Gordon O'Brien, Frank W. Wilkisson, Charles Bevis, George E. Steele

Studies on Marine Insurance on Commercial Fishing Vessels

Warner C. Danforth

Q. Wilkinson: Do the insurance companies give out any information which would enable the fishing industry to make improvements and changes in their vessels which would bring about lower insurance rates?

A. Kahn: It is difficult to extract information from the insurance firms since they are often reluctant to divulge what they consider secret information. On the other hand, payment is often asked for information. In many cases insurance is held by foreign companies represented by big law firms and no information can be gained there. But, Dr. Danforth expects to provide such information as part of his study.

Q. O'Brien: Is consideration given by insurance companies in computing rates, as to the qualifications of fishermen, particularly of skippers and mates?

A. Van Sciver: The agent makes the decision on the past record of the persons involved and is usually the final judge of what constitutes a good or poor risk.

THURSDAY—NOVEMBER 29

Chairman—ARNIE J. SUOMELA, *Associate Director, U. S. Fish and Wildlife Service, Washington, D. C.*

The Status of Scientific Knowledge about the Red Snapper (Lutjanus aya Bloch) and the Economic Importance of this Fishery

JEROME E. STEIN

ABSTRACT

Although the red snapper was found to be the third largest fin fishery in the Gulf of Mexico, there was a paucity of scientific information on this animal. Various programs were suggested to fill the gaps of ignorance in order to further develop the industry.

Biological Investigation of Atlantic Coast Menhaden

FRED C. JUNE

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Fish and Wildlife Service, Beaufort, N. C.

INTRODUCTION

THE MENHADENS of North America constitute a resource supporting the largest fishery in the Western Hemisphere. In 1955 landings amounted to over 1.8 billion pounds, or roughly 40 per cent of the total fish production in the United States.

The bulk of the catch is taken by purse seine vessels operating from reduction plants located on the Atlantic and Gulf coasts. A small, but significant, quantity also is taken by pound nets in the middle Atlantic region and in Chesapeake Bay. The catch is processed into fish meal, oil, and condensed solubles.

Four species of menhadens occur throughout the range of the fishery; however, the Atlantic form, *Brevoortia tyrannus,* is by far the most important. It comprises an estimated 75 per cent of the combined annual menhaden production. A second species, *B. smithi,* occurs on the Atlantic coast, but it is of no importance to the fishery at present.

The large-scale commercial fishery for menhaden had its beginning in the late 1850s when the mechanical screw press was adopted for recovering the oil. The fishery subsequently grew rather slowly until about 1870 when the use of steam and the hydraulic press for processing the fish enabled the factory stage to become fully developed. The fishery during this period of expansion was centered in the Gulf of Maine and extended southward along the middle Atlantic coast to southern New Jersey. By 1876 the factories processed approximately 310,000,000 pounds of fish to produce nearly 3,000,000 gallons of oil and over 50,000 tons of fertilizer. In the 1880s the center of menhaden produc-

tion shifted to the middle Atlantic region following the disappearance of the fish in the waters north of Cape Cod. Subsequently, the fishery expanded southward along the Atlantic coast and into the Gulf of Mexico.

The recent growth of the Atlantic coast fishery is illustrated in Figure 1, showing the landings from 1929 through 1953. It may be seen that the fishery has undergone a marked increase over the 25 year period, with fluctuations clearly evident. The rise in the 1940s was due, in part, to the increased demand for fish meal as an animal feed ingredient. The discovery of vitamin B_{12} as an important constituent of the animal protein factor found in fish meal emphasized the importance of menhaden as a source of this product. Undoubtedly the marked decline of the California sardine and Pacific herring fisheries contributed greatly to the increased demand for menhaden meal.

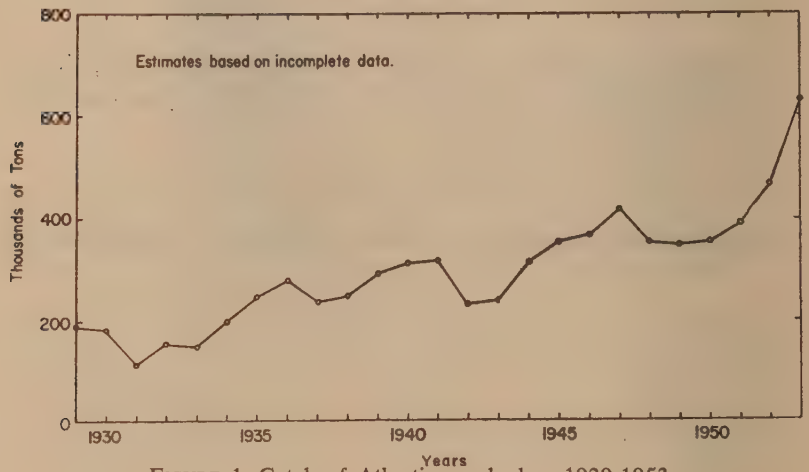

FIGURE 1. Catch of Atlantic menhaden, 1929-1953.

The menhaden fishery, from its inception, has been subject to great variations in yield. The catch in one region of the coast sometimes differs markedly from those in other regions, or even in adjacent localities in the same season, and periods of high production in a given locality often are followed by several years of poor fishing. Perhaps the most striking example of these vicissitudes was the complete collapse of the fishery in New England in the 1880s. In 1876 seventeen factories located in Maine utilized nearly 142,000,000 pounds of menhaden. Several years later the fish had almost completely disappeared, and except for one or two seasons, they did not return to those waters for nearly 50 years. Since 1950, production in the Gulf of Maine has gradually increased, and a modern record, based on preliminary data, of over 66,000,000 pounds were produced in 1956.

BIOLOGICAL INVESTIGATIONS

An investigation of the menhadens of the Atlantic coast was undertaken early in 1955 by the U. S. Fish and Wildlife Service. The program is an expansion of preliminary biological studies initiated in 1952. The program of investi-

FIGURE 2. Geographical distribution of purse seine fishing, 1955.

gation is designed to determine the causes of fluctuations in the fishery and the extent to which these are predictable. Since *Brevoortia tyrannus* at present is the only important species in the commercial fishery in the Atlantic, research activities, for the most part, have been limited to this species. The immediate objectives of the work are to (1) determine the structure and relationships of populations, (2) gather knowledge respecting its life history and biology, and

(3) follow changes in the age and size composition of the stock in relation to fluctuations in the catch. In addition, measurements of catch, fishing effort, and abundance are being compiled from records of landings at the reduction plants and fishing logbooks kept by the fishermen.

DISTRIBUTION

The present distribution of the Atlantic menhaden *(B. tyrannus)* is known to include the area roughly from Boothbay Harbor, Maine, southward to Daytona Beach, Florida, and offshore to a distance of less than 75 miles. It is not found in equal abundance throughout this range, but is concentrated in localities where feeding conditions appear to be most favorable. It is found in greatest numbers during the warmer months of the year when the fish congregate at the surface in schools of many thousands and even millions of individuals.

The commercial fishery covers the presently known range of this species. In Figure 2 is shown the geographical distribution of purse seine fishing, with the areas of heaviest concentration shaded more heavily. The data on which the figure is based are taken from fishing logbook records kept by vessel captains and pilots.

POPULATIONS

Since the Atlantic menhaden occupies some 3,000 miles of coastline, it is necessary first of all to determine whether it exists as a single, freely intermingling and interbreeding group of fish, or whether there are several independent or semi-independent groups, each with its own biological peculiarities.

From several lines of evidence we have concluded tentatively that there exists at least two distinct populations. Comparisons of average numbers of vertebrae, fin rays, and ventral scutes of juvenile menhaden reveal rather large differences between those fish inhabiting estuarine nursery areas north of Long Island and those occurring south of Long Island. Furthermore, size frequency distributions indicate that juveniles occurring in those estuaries north of Long Island reasonably could not have arisen from the same spawning as those from farther southward. Those from northern waters are considerably smaller than those in estuaries south of Long Island.

It is known that a major spawning occurs off the coast of the Carolinas during the fall and winter months. There also is evidence to indicate that a separate spawning, presumably by a different group of fish, occurs in waters north of Long Island in the spring and early summer under very different environmental conditions. Thus, it is hypothesized that adult fish segregate into at least two distinct groups for spawning, and the observed differences in body structure of juveniles are induced either by inherited tendencies which are preserved, or differences in environmental conditions at the time of spawning, or they may result from the interaction of both influences.

Persistent differences in size of menhaden of the same age also occur. Two and three year old fish, for example, are larger in the northern limit of the geographical range of a year class; smaller fish occur farther south, while those intermediate in size are found in the central region. These differences are believed to represent differences in growth rates arising from different populations.

We also are studying body structure of spawning fish from both the northern and southern areas to determine whether they differ and the extent to which they resemble juveniles from adjacent nursery areas. However, progress on this work has been too limited to permit any conclusions at this time.

Knowledge of the basic features in the life history and biology of menhaden and their relation to the physical and biological environment is essential to understanding changes within populations and their effects on the fishery. If the events in the life history of each year class could be followed closely from the time of its origin as eggs on the spawning grounds, it is likely that the reasons underlying its success or failure could be adduced. Certain stages in the early life history, for example, may be found to be especially critical, explaining why variations in year class survival occur. Thus, determination of the causes of variation in mortality rates of eggs and young would aid in predicting the abundance of year classes.

To provide a frame of reference for the execution of an investigation of this type, we have begun with the earliest stage in the life history, i.e. spawning. Detailed studies are being made of the gonads of fish sampled from the pound net and purse seine fisheries throughout the year to determine the times and places of spawning and the size and age at which sexual maturity is attained. In addition, limited plankton work, both at sea and in estuaries, is being conducted to determine the distribution of eggs and larvae in time and space.

Results thus far obtained indicate that spawning occurs over a wide geographical range and during the entire year. Spawning appears to be largely concentrated in the fall and winter months off the coast of the Carolinas. This spawning appears to have its beginning in the vicinity of Long Island, and possibly farther northward, in the fall when a southward movement of the fish is in progress. Based on extensive sampling of the catches over the past three years, all fish present in those waters at the close of the fishing season in October have been found to be sexually mature; however, roughly only 60 per cent are in spawning condition. The remainder, comprising fish of the same size and age, are in non-spawning condition. Several weeks later identical size and age groups of fish occur in the fishery off the North Carolina coast, but only fish in spawning condition have been found in our samples to date. These findings suggest that although fish in varying stages of sexual development occur together in northern waters in late summer and early fall, spawning fish somehow become segregated from non-spawning individuals between the time of the disappearance of the former group from Long Island waters after the close of the purse seine fishing season and the appearance of spawning fish in North Carolina waters a short time later. Indeed, fish in non-spawning condition, representing the same size and age groups, have been taken in large numbers by the pound net and mackerel gill net fisheries along the New Jersey coast at the same time that spawning fish make their appearance in North Carolina waters.

It also appears that a later spawning takes place in waters north of Long Island in spring and early summer. Fish with gonads in developing stages of ripeness enter the pound net fisheries in the vicinity of Raritan Bay and central Long Island normally in March and April. Within a period of several weeks, these fish disappear from the fisheries, and a short time later, identical size groups, with many individuals in partially spawned-out condition and others in advancing stages of ripeness, make their appearance in the pound net catches in the vicinity of Block Island. Nowhere else along the coast are fish in spawning condition encountered at that time of year.

We presently are developing a method, based on ova diameters and ovary weight, of determining rapidly and objectively the stages of maturity of the

gonads to provide more efficient and extensive information concerning these phenomena.

Present knowledge indicates that spawning and early larval development take place entirely in the ocean and possibly are limited to the waters over the continental shelf. Some time after absorption of the yolk sac, the larvae enter estuaries and bays and spend the following several months of their life in these nursery areas. In the fall the juveniles emigrate from the estuaries and apparently migrate southward, for they occur in tremendous numbers along the coast of North Carolina in late fall, and frequently large schools may be seen along the shore in northern waters traveling in a southward direction. Furthermore, during the following summer these fish appear as one year-olds only in the southern and central parts of the range. Such a distribution would be possible only if juveniles migrated into those waters sometime after they left the estuaries.

Investigation of the biology of larval menhaden also is being conducted under controlled conditions in the laboratory. Preliminary studies of their feeding habits, using radioactive tracer elements, suggest that, following absorption of the yolk sac, they feed mostly on copepods, a small crustacean. A change in feeding habits is believed to occur when the gill rakers (a straining apparatus) become developed. At this later stage their food consists predominantly of microscopic plants and animals, including diatoms and flagellates. Other experimental studies are concerned with rearing larvae under different conditions of temperature and salinity to determine the effects of these factors on growth and morphology.

An intensive study of the estuarine life of juvenile menhaden also is being carried on at our field laboratory located at Indian River, Delaware to determine (1) mortality rate, (2) growth, (3) amount of intermingling of juveniles within the estuary, (4) feeding habits and food preferences, and (5) responses of populations to changes in physical and biological features of the environment.

Results of this work indicate that juveniles do not occur randomly in the nursery areas, but tend to be congregated where phytoplankton production is highest. Growth under these conditions is rapid, for by the time that they are ready to emigrate from the estuaries in the fall, young fish have attained a maximum length of about six inches. Varying conditions of salinity, temperature, and oxygen also influence the distribution and behavior of juveniles in the estuaries. The most difficult problem concerned with the estuarine phase of the program is to devise suitable measures of mortality rate and abundance. The findings to date respecting these two features are inconclusive, but some have been noted which will form a basis for future work.

Following their early life in the estuaries, menhaden appear to be restricted to the littoral, or coastal, waters to roughly the 20-fathom curve. One of the most outstanding characteristics of the fish is its tendency to aggregate into dense schools near the surface. A further feature, significant to the study of its biology, is the tendency of individuals of the same size to school together. So far as we know, juveniles, following their emigration from estuarine nursery grounds, always school separately. One year old fish usually do, but the largest may join schools of smaller two year old fish. Furthermore, differences in the size distribution of samples from schools in a given area indicate a tendency for schools of a given size range to occur together distinct from those of an adjacent, but overlapping area.

Sampling of the catches to obtain estimates of various parameters of the popu-

lation, therefore, involves drawing samples from a large number of different schools over the range of the fishery during given time periods. The main purpose underlying this phase of the investigation is to study variations in the strength of successive year broods, or year classes, of fish and their effect on the catch. These data also will furnish information on growth, migrations, mortality rates, and the population structure of the stock. In addition, information is being obtained on other pertinent biological features, including length and weight of fish at each age, sex ratio, and spawning.

Our present sampling program consists of obtaining representative samples of the catches at each location along the Atlantic coast where pound net and purse seine fisheries are active. The number of samples taken is roughly proportional to the catch in each locality.

The results of this work over the past two years reveal several outstanding features. Most important of these, perhaps, deals with the distribution of size and age groups in the fishery. During the summer months the older, sexually mature fish occur only in northern waters, while the younger, sexually immature fish occur only in the southern and central parts of the range. The data further indicate that one year old fish gradually move northward during the summer, and by late summer, most of the one year old fish have disappeared from southern waters. In each succeeding year this northward movement of a year class becomes more pronounced. Thus, a gradual mixing of size and age groups takes place. A southward migration occurs in the fall and early winter when those size and age groups occurring in the summer fishery north of Cape Hatteras appear in the fall and winter fishery off the coast of North Carolina. There appear to be slight variations in this generalized pattern of distribution from year to year. One year old fish, for example, may occur as far northward as New Jersey in some years, while in other years, they may reach no farther northward than Virginia. Furthermore, during mild winters, one and two year old, sexually immature fish apparently do not all move southward, for great numbers are taken in the pound net and gill net fisheries off the Maryland and New Jersey coasts.

Another significant finding is that marked variation in year class strength is evident. Although not completely documented, the 1951 year class, for example, predominated in the catch for several years and still is contributing an important share of the landings. The 1952 year class, on the other hand, appears to have been a rather poor one and has contributed relatively little to the fishery. A great deal remains to be learned, but sufficient data are being accumulated to assess this feature of the fishery.

MEASUREMENTS OF CATCH

Measurements of the abundance, amount of fishing effort, and total catch of menhaden are essential for evaluating and interpreting fluctuations in the fishery. These statistics require detailed data over a series of years regarding the time, place and amount of the catches, together with information on the amount of fishing effort that is required to take them. Such information is being obtained from the records of individual vessel landings kept by the processing plants and from fishing logbooks kept by the fishing fleet.

Measurements of total catch, apparent abundance, and total fishing effort have been completed for the middle Atlantic area from 1939 through 1954. A second measurement of apparent abundance is being calculated based on the

logbook data. The two series of measurements will be compared to determine if they indicate the same conclusions.

Compilation and analyses of these basic data have been partially completed for the south Atlantic and Chesapeake Bay areas. Progress on this phase of the program has been slow because of the great bulk of material; however, we hope to complete the analysis of the historical data during the coming fiscal year.

Studies on the Life History of the Spotted Sea Trout, Cynoscion nebulosus (C. & V.)

DURBIN TABB

The Marine Laboratory, University of Miami, Coral Gables, Fla.

ABSTRACT

Apparent declines in inshore fish population have been reported for a number of years. These declines, particularly since 1945, in Florida have been attributed to such factors as the increasing number of tourists, new residents, land drainage, pollution, etc. The spotted sea trout is fairly well represented along the coastline from Virginia to Mexico. This study limits itself to the area between Stuart and Titusville on the Florida east coast. Studies of spawning, age, growth, food habits and abundance are being carried out.

Information is being obtained to establish the relative percentage of the total catch provided by each segment of the fishery—sport hook and line, commercial hook and line and commercial gill netters.

Studies as to seasonal trends in availability and seasonal migrations are also being conducted.

Field and Laboratory Observations on the Growth of some Bermuda Reef Fisheries*

JOHN E. BARDACH and DAVID W. MENZEL

Fisheries Department, University of Michigan, and Bermuda Biological Station for Research

MOST TROPICAL AND SUB-TROPICAL FISHERIES have as yet not been under sufficient scrutiny to allow an estimate of the rates of fish production, or even, for that matter, of the numbers of fish present at any one time. Bermuda waters can, with some license, be called sub-tropical. Here the fishery pursued relies primarily on reef-bound species rather than on pelagic fish (Mowbray, 1947). The fishing area is relatively small and clearly defined and lends itself well to field observations. Fishery research in Bermuda might, therefore,

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*This work was supported jointly by a grant from the National Science Foundation and the Bermuda Government Fisheries Research Program.

attempt to estimate reef productivity in terms of fish flesh, first for its principal commercial species and eventually for all reef fishes.

The production of fish in a given area can be estimated only if the rate of growth and the rate of mortality are known (Ricker, 1946). We measured the rate of growth and we could obtain some indication of fishing mortality from the commercial landings. In the absence of any means by which to measure natural mortality and to detect a change caused by man in the stable ecosystem of the reef, we must assume that there is no overall increase in the total fish population. Whether there is a decrease, as some commercial fishermen vociferously claim, only further and more intensive studies can show.

We chose the approach of studying the growth of certain representative species, of obtaining a fairly complete picture of size and numbers of these fish by all censusing methods available, and of then attempting a best guess, or estimate, of their yearly growth.

Growth was measured by following the weight increments of marked fish in the field. At the same time individuals of one species were kept in the laboratory for short periods and weight gains upon saturation feeding were compared with the field data.

Marks do occur on the scales of many Bermuda fish, but they were not used for growth estimations since they could not be definitely ascribed to differential growth rates influenced by seasonal temperature changes.

Reef fish populations are characterized by having numerous species with relatively few individuals of any one species. This, and the decentralization of Bermuda's commercial fishery, make it difficult to obtain sufficient numbers of individuals of different size to allow analysis of growth by means of size-frequency distribution.

A shallow reef in the outer reef chain which rises vertically from the sandy lagoon of 60 feet depth to a depth of 3-5 feet on its pinnacles, and 15-20 feet in its sandholes, was selected for this study because of its representative fish fauna, its relative position to other reefs, and its accessibility (Figure 1). On its 2.47 acre (1 ha.) surface, fish traps were set, albeit at irregular intervals, for over a year. Fish were tagged with plastic streamer tags and metal jaw tags, and measured to the nearest millimeter at tagging, as well as on recaptures during the year. Fish caught and retained elsewhere allowed us to construct length-weight diagrams for the species involved. Weighing of the tagged fish themselves was dispensed with for the sake of returning them to the water as quickly as possible.

The Nassau grouper *(Epinephelus striatus),* the red hind *(E. guttatus)* and some rockfish (gen. *Mycteroperca*) were recaptured in sufficient quantities to give us an indication of their yearly and seasonal weight increments. The hind was also observed in the laboratory. Incidentally, the rockfish, the Nassau grouper, and to some extent, the hind, are commercially exploited; in fact the grouper represents 30-40 per cent of Bermuda's fish catch.

It should also be said that neither the rockfish nor the Nassau grouper attain their maximum sizes in the shallow reef environment. It would, however, have been too much to hope for at present to enlist sufficient cooperation from commercial fishermen to allow us to tag and release repeatedly a significant number of large individuals of these species.

Red Hind (*Epinephelus guttatus*)

This species is one of the most prevalent small groupers of the shallow reefs.

It occurs down to about 30 fathoms in fair abundance and some individuals have been taken at 50 and 60 fathoms. The fish grow to an adult size and weight of 18 inches (445 mm) and 3 lbs. (1375 g.) respectively. Their average size and weight is about 350 mm and 600 g. Sexual maturity is reached at 300 mm and 400 g.

Sixty individuals of 300 mm or more were tagged in 1955; 22 of these were recaptured after periods of 50 to 365 days. The annual weight increment, based on measurements at recapture, is 20 to 25 per cent for the fall and winter months and 40 per cent for the period from March to September, the season of more rapid growth. We changed from plastic streamer to monel jaw tags in February 1956. While these tags were faster and easier to apply, it was noticed that some of the streamer-tagged fish had grown more than those which bore metal tags on their jaws. The summer growth figures from the field are therefore believed to be on the low side, compared to untagged fish.

Three size groups of hinds were kept in the laboratory for 21 days and fed on sardines (locally called anchovies) *(Sardinella anchovia)* and pilchard *(Harengula sardina)*. They were given daily as much food as they would consume. Notably different growth rates were found to prevail at different temperatures. At 72°F. (22.2°C.) size group I (240-440 g.) gained 79.1 per cent, size group II gained 132 per cent, while the largest size group (III) hardly fed at all and gained only 5.2 per cent of their initial body weight when growth was prorated annually.

At 83-85°F. (29°C.), in midsummer, the smaller sized fish gained 247 per cent and the medium sized fish gained 273 per cent, on a yearly basis. These figures are extremely high when compared to field data. Presumably this is because the fish would not continue to feed at as high a rate as they did initially for an extended period of time.

Serranids vary in the degree of tameness they exhibit in confinement. Hinds are about the tamest of the lot and begin to feed immediately and voraciously. For a few days, during the summer, they consumed 8 per cent of their body weight daily and tapered off to about 4 per cent after three days. The large discrepancy between laboratory and field data here may further be due to the fact that the fish in the tanks move very little and therefore expend less energy from day to day, and that food in such abundance as is available on saturation feeding is probably never present in the field—at least not for a number of days in succession. The true yearly weight gain of this species is in all likelihood somewhat higher than that obtained from our tagged fish.

The total number of hinds on the experimental reef was estimated from the ratio of tagged to untagged fish and from two "Scuba" counts; 110 red hinds occurred on the 2.47 acre area in midsummer. If we assume then that 44 hinds are present per acre and that they weigh 600 g. (on the average) and gain 40 per cent of their body weight per year, their contribution in growth to the yearly production is roughly 25 lbs. per acre (25 kg./ha.). We considered summer growth ratios representative for the year because of the bias due to jaw tagging.

Nassau Grouper (*Epinephelus striatus*)

Twenty-one individuals of various sizes up to 6.6 lbs. (3 kg.) were tagged. Seven were recaptured, some of them repeatedly. They also revealed a decline in growth after jaw tags were applied. Too few fish of this species were

captured to attempt a breakdown into size groups and only an indication of their yearly increment can be given. Nassau groupers of this size are just reaching sexual maturity and many probably move off into deeper water later in their lives. It might therefore be expected that they would grow quite rapidly. However, we measured growth rates of only between 20 and 55 per cent per year, with an average of 38 per cent.

Our reef held 30 groupers (estimated as above). Their average weight was 2.5 lbs. (1115 g.). Therefore there were 12 fish per acre which weighed about 30 lbs. in aggregate. We again assumed a yearly increase of 40 per cent in the body weight because of jaw tag bias and estimated a growth of slightly less than 12 lbs. per acre per year (12 kg./ha.).

ROCKFISH (*Mycteroperca bonaci, M. falcata*)

The shallow reef is a niche for the young of these species; no rockfish over 11.5 lbs. (5.2 kg.) was captured for tagging and only four out of 17 tagged fish yielded fairly reliable growth figures. These indicated that young rockfish of less than 10 lbs. in weight (3.5 lbs. on the average) gained between 60 and 75 per cent of their body weight per year. These figures represent plastic tag recaptures after about one year and are assumed to be representative of true growth.

Eighteen miscellaneous rockfish (other than *E. striatus* and *E. guttatus*) were estimated present on the reef. Seven fish, together weighing about 25 lbs., occurred per care. At 60 per cent gain this represents a yearly rockfish growth of 15 lbs. per acre (15 kg./ha.).

Having estimated the growth of the principal commercial species, even if we do not have the natural mortality rates, we can compare our estimates of accretion due to growth with our assessment of removal by man and see at what level the reef fishes of Bermuda are being exploited.

In the absence of official landing records for the Bermuda fishery one has to resort to the next best method of estimating the landings, that is to secure the cooperation of a few representative fishermen who are willing to supply reliable figures of their daily and seasonal catches. This information is then supplemented with figures obtained from large and small-scale consumers, or middlemen, so that a best guess at the total landings can be made. In a fishery as restricted as ours this procedure has yielded fairly reliable figures. About one and a quarter million pounds of fish in the round have been landed yearly by an odd 80 to 100 full or part-time fishermen. (Bardach and Mowbray, 1956). A quarter million pounds of this are floating fish, carangids and seriolids, and the rest is made up of reef fishes proper, predominantly serranids.

The fishing area extends roughly over 400 square miles of reef shallower than 40 fathoms (Figure 1). It is not of uniform quality as a fishing ground and the bulk of production comes from the two offshore banks, *Challenger* and *Argus*, which extend over about 70 square miles, and the outer reefs, which surround Bermuda at a varying distance of 3 to 10 miles, and cover about 150 square miles. Thus we deal with about 220 square miles of "heavily" fished reef area.

Fishing is done mainly with wire traps and handlines at depths of 2 to 30 fathoms. The regions from ten fathoms down are more heavily fished than the shallows because the size of the larger serranid fish seems to increase with depth. This was borne out by the analysis of 175 trapsets where the average weight of the commercially usable catch per trap was 7.13 lbs. (3.24 kg.)

FIGURE 1—Fishing grounds around the Bermuda Islands. The dotted lines indicate the 500, 1000 and 2000 fathom marks.

between 10 and 30 fathoms, against 3.45 lbs. (1.57 kg.) between 2 and 9 fathoms. The fish were mostly serranids; their average weight in the deep traps was almost twice that in the shallow catches. The complement of herbivorous fish per trap also increases in shallow water. Five carnivorous fish, mostly retained for market, to each one herbivore occurred in the 102 traps between 10 and 30 fathoms, while the shallow traps caught one herbivore for each two carnivores, on the average. These herbivores, mostly parrott, angel, and surgeonfish, are not landed but used as bait on the spot.

On the shallow reef studied by us, we estimated the yearly growth of commercially used serranid species at 52 lbs. per acre. Sizes and species composition from the deeper traps suggest a greater proportion of large to small serranids than on the shallow reefs. On the other hand, we may have attracted a number of serranids by continuous baiting. Thus we take our figure of around 50 lbs. per acre as representative for the "heavily" fished reef regions around Bermuda which then produce at least 4,800,000 lbs. of "harvestable" serranids per year. The outer banks, on the same basis, add 2,240,000 lbs. to this figure. The harvest from there is, at present, not believed to exceed 200,000 lbs. a year, while the reef region around Bermuda yields about 700,000 lbs. of demersal

reef fish yearly, with an additional 100,000 lbs. being caught in the inshore and South-shore areas (Figure 1). Most, though not all of these, are serranids.

On the basis of these calculations we can make some general statements about the Bermuda fishery although the growth is probably estimated low and the landings rather high.

1) The harvest from the outer banks is likely to increase more rapidly than that from the Bermuda reef area proper. This development is now in progress and will be accelerated with improved methods of keeping the catch fresh, such as small refrigeration units aboard ship, and antibiotic treatment.

2) A harvest of 10-15 per cent of the yearly weight increase in fish flesh, secured by relatively primitive means because of environment imposed conditions, is not likely to yield a substantial increase with a concomitant increase in fishing effort without a drastic change in technique, for instance, electrofishing. If only serranids are marketed, the entire area is undoubtedly capable of yielding from 50-70 per cent more than it yields at present, but a substantial boost, such as a doubling or trebling of the present Bermuda harvest, will more than likely come from:

a. An increase in the harvest of floating fish.

b. Commercial harvest of the, at present, unused Tuna resources (Mowbray, 1955).

c. Partial harvest of the other now unused and little used species.

It should be mentioned in closing that Bermuda has a population of 41,000 (private communication Colonial Sec., Sept. 1956) and, since the U.S. Forces stationed in Bermuda hardly consume any fish secured through commercial channels, one only has to add to the above figure 2,500 persons which represents the tourists prorated on a yearly basis (Bardach and Mowbray, 1956). A harvest of 568 metric tons (1¼ million lbs.), for a population of 43,5000 results in an average per capita landing of 13 kg., or landings of over five metric tons per fisherman. This is comparable to the estimated per capita fish production of Finland, France and Western Germany and indeed to that of the United States (Morgan, 1956). It certainly exceeds the per capita production of many Caribbean countries, with the exception of Venezuela. One reason for this relatively high degree of efficiency in Bermuda's fishery is to be found in the fact that nearly all fishing vessels are motorized.

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TABLE 1
GROWTH RATES OF CERTAIN BERMUDA REEF FISHES

Species and size groups	*% growth winter (per annum)*		*% growth summer (per annum)*		*Average field growth (prorated)*
	field	lab	field	lab	
Red hind					
600 g.	20		40		38%
250-400 g.		79		247	
500-700 g.		132		273	
800-1200 g.		5			
Nassau Grouper					
700 g.			20-50		40%
Rockfish					
1000 g.					60-75%

A Survey of Spearfishing in the Florida Keys

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IN FLORIDA, spearfishing is defined legally as "the taking of any marine life through the instrumentality of a spear, gig, or other device operated by a person submerged in the water." As a commercial method spearfishing has generally been abandoned in favor of more productive means in Florida, but it is still used to a limited extent where fish can be found concentrated in certain areas or at certain times of the year.

Spearfishing has only recently been practiced as a sport. During the period from 1930 to 1935 a few individuals began this activity in Florida as well as California, Hawaii and in the Mediterranean. The early development was mostly in California and France, and much of the equipment used today comes from these places. Basic equipment includes a diving mask, swim fins and any one of the various types of spearguns or devices.

Prior to World War II there was little interest in the sport, but during the past ten years the number of spearfishermen has greatly increased. They formed many clubs which by 1950 were sufficiently numerous and organized to hold a national competition meet at Laguna Beach, California. In 1956 a national competition was held at Marathon, Florida, under the auspices of the Amateur Athletic Union which has recognized spearfishing as a new sport.

In Florida spearfishing clubs have been formed, principally along the lower east coast and in the Tampa-Sarasota-Bradenton area.

The most common places fished by spearfishermen in Florida are the shallow waters above coral reefs, near jetties, piers and bridges, and in channels or potholes. These places formerly were fished almost exclusively by hook and line fishermen, but since 1950 an increasing number of spearfishermen have been operating there.

In 1951 the Florida State Board of Conservation requested The Marine Laboratory to make a preliminary investigation in Palm Beach County to determine whether the methods of spearfishing used were contrary to conservation

[1]Contribution No. 181, The Marine Laboratory, University of Miami.

aims and practices. These conservation aims were briefly stated as the control of the exploitation of fish stocks so as to give the maximum sustained yield to all legitimate activities, whether angling or commercial fishing—whether by seining, hook and line, or spearing.

The resulting report (Brady, 1951) stated that in the case investigated there appeared to be no fundamental conflict concerning spearfishing with the above concept. Snook were the principal species involved in this investigation and the removal of snook by daytime spearfishing did not amount to a significant quantity. It was estimated to be considerably less than that of angling or of commercial fishing. It was recommended therefore that daytime spearfishing be allowed to continue. Night-time spearfishing, on the other hand, could account for single nightly catches of 500 pounds per man. This night activity accounted for the greater part of commercial underwater spearfishing. There was the strong possibility that, in the locations that were fished by spearfishermen at night, the local population might be reduced, at least temporarily, and that these activities were liable to be injurious to the purely local fishery, both commercial and angling. It was therefore recommended that underwater spearing of fish at night be prohibited.

Brady's report pointed out that while simultaneous activity of spearfishermen and anglers at certain places is possible, it is hazardous to both, and totally unsatisfactory to the angler. The sociological and economic question of whether angling, spearfishing or commercial fishing was to be encouraged at the expense of the alternative activities was brought forth but was not the primary concern of the investigation.

With increased fishing pressure by spearfishermen the Florida State Board of Conservation has found it expedient to regulate the activities of this group. Prior to 1950, Florida had few laws pertaining to spearfishing and those were enforceable only in local areas. Since this time, at least ten additional laws have imposed greater limitations on spearfishing and in 1956 restrictions were in force in 13 counties of the state.

Many of these restrictions are necessary or convenient to solve economic or social problems when simultaneous activity by spearfishermen and other groups is hazardous, or where spearfishing interferes with the accustomed practices of a majority group. Some laws prohibit the sale of speared fish; others close small areas to spearfishing, especially near bridges and in inlets where, besides conflicts with anglers, there is the danger of collision between boats and spearfishermen.

From the point of view of utilization by spearfishermen, many areas are still open in the state for them to pursue their sport and obtain a share of the catch. Many other states, however, either prohibit spearfishing entirely or do not have any appreciable amount of spearfishing owing to adverse local conditions (e.g. cold water, turbidity).

With growth of interest in this sport, and as more areas become closed to spearfishing, it can be expected that increasing effort will be concentrated in favorable areas still open to spearfishing.

Monroe County (the Keys) is a desirable area for spearfishing. This location has a submarine bank along the oceanic side of the Florida Keys which varies in width from more than three to nearly seven nautical miles. This bank is covered by less than 60 feet of water as far as its eastern edge, where it slopes down to the Florida Strait. Most of this bank lies under less than 30 feet of water. Much of this shallow inshore area consists of mud or sand bottom which can be easily seen from the surface when the water is clear. These waters

soon become turbid during rough weather, but even in calm weather this shallow area is generally not attractive to spearfishermen due to the small number of fish that can be found there.

There are, however, many patches of corals scattered along this bank. These patches and the irregular coral reef which runs along the seaward edge of this bank are favorite fishing grounds for spearfishermen. This reef reaches no great depth, and its most flourishing growth of coral lies in less than 60 feet of water. The reef extends in a southwesterly direction from the vicinity of Fowey Rocks, south of Miami, to the Marquesas, which lie beyond Key West.

The growth of interest and activity in spearfishing in this area is shown by the fact that in 1956 there were at least ten charter boats taking spearfishing and diving parties to the reefs along the Florida Keys, and about 15 fishing camps whose facilities spearfishermen used. These charter boats, with two exceptions, have been operating in this manner only for a few years. These fishing camps had few, if any, spearfishing parties before 1950.

Fishing Effort and Landings

In 1956 the Florida State Board of Conservation was requested by interests in the Upper Keys to restrict spearfishing in that area. This request was granted on a temporary basis. At this time, Mr. Ernest Mitts, Director of the State Board of Conservation requested that The Marine Laboratory of the University of Miami make estimates of the numbers of spearfishermen operating and of the the numbers of fish they catch as a method of assessing the fishing pressure by this group.

Soon after this study was started the Upper Keys area, for which information was requested, was closed to spearfishermen. This made it difficult to collect the information sought, but data were collected on the fishing pressure of spearfishermen, the seasonal and temporary factors affecting fishing effort, the species caught and the areas fished in Monroe County.

The following facts and estimates are presented to indicate the extent of spearfishing activities in Monroe County.

During a canvass of the Florida Keys, twenty places were found where spearfishermen were known to rent, launch or charter boats for the purpose of fishing in offshore waters. Estimates were made of the total number of spearfishermen using each of these sites during the period from August 1, 1955, to July 31, 1956.

Charter boats and operators which catered to spearfishermen were located as follows:

Operator	Location	Estimate of year's total fisherman days
The Skin Diver		
R. B. Lieberg and R. Weber	Key Largo	500
R. Zimmerman	Key Largo	500
Hugh Brown	Whale Harbor, Upper Matecumbe Key	1000
Seahorse Motel		
Bartelt Bros.	Marathon	400
James Kelly	Marathon	200
Mat Ferguson	Marathon and Summerland Key	50
Ed Cizinski	Key West	200
	Sub Total	2850

Locations where boats were rented or launched for the purpose of spearfishing were as follows:

Location	Estimate of annual total fisherman days
Jewfish Creek, Key Largo	20
Gulfstream Lodge, Key Largo	600
Garden Cove, Key Largo	300
Mayo's Fish Camp, Key Largo	750
Lower Key Largo (2)	500
Plantation Key	20
Matecumbe Key	260
Vaca Cut	100
Marathon	200
Little Torch Key	350
Summerland Key	250
Key West	500
Sub Total	3850

Many species are included in the spearfishermen's catch. Groupers, hogfish, jewfish, jacks and snappers are prominent. Others such as snook, barracuda, lobster, sharks, moray eels, rays, angel fish, parrot fish and turtles are also landed.

The species of fish caught by spearfishermen are also landed by anglers and by commercial fishermen. However, the most important commercial landings in the Florida Keys are king mackerel, Spanish mackerel, shrimp and spiny lobsters, while in the hook and line sport fishery many species such as trout, tarpon, bonefish, dolphin and the bigger game fishes are taken, which are not usually caught by the spearfishermen.

There are actually four groups of spearfishermen, whose average catch per day is different.

(1) Residents of Florida who are members of spearfishing clubs:

They spend a much greater number of days fishing than spearfishermen who are not club members. Questionnaires revealed that these men spent an average of 87 days fishing during the year, (although not all this time was spent in the Keys). Their average catch was estimated to be 13 pounds per fishing day.

(2) Residents of Florida who are not members of spearfishing clubs:

These people typically spent some weekends spearfishing, making one day journeys from the Miami area to nearby locations in the Keys. They usually limit their spearfishing activities to the summer months. They either rent a boat or launch their own boat from a fishing camp. Their principal targets are hogfish and groupers. Their replies to questionnaires indicate their average catch is about 5.5 pounds of fish per day, and that they fish about 15 days during the year.

(3) Florida has also attracted spearfishermen and divers from other parts of the United States, who come to explore and fish over the coral reefs. They are from all walks of life: students, university professors, factory workers, businessmen and many other groups. Most are young men, but women, older men, and children are also represented. These people spend a limited vacation in Florida, during which time they spend several days spearfishing.

Thirty of these fishermen were interviewed. The average catch of these people was higher than the 5.5 pound estimate derived from questionnaires, and was closer to 13.5 pounds.

(4) Commercial spearfishermen: From interviews of fish dealers and from those who sold speared fish, it was learned that in the study period there were at least 20 spearfishermen who regularly sold their catches, which averaged over 100 pounds per fishing day.

From interviews with commercial spearfishermen (none of whom earn their whole income from this activity) it appears that a crew of three men, with two men fishing, and the third operating the boat, can average about 300-400 pounds of fish per day (150-200 pounds per active fisherman), fishing about two days a week throughout the year. To obtain the highest price possible for their catch some sell directly to restaurants, while others sell to fish wholesalers. The species caught by the commercial spearfishermen are mostly hogfish, groupers, and occasionally jewfish and barracuda. These fishermen also land spiny lobsters but different methods of capture are used. Although they prefer to fish in areas close to their markets, they operated along the entire stretch of keys in search of the most productive grounds. It appears that this commercial spearfishing activity has decreased in the last two years.

It was estimated that the combined activity of these groups in the Florida Keys from August 1, 1955, to July 31, 1956, totalled about 6700 spearfisherman days. The total catch landed by spearfishermen in Monroe County from August 1, 1955, to July 31, 1956, is estimated to have been 207,000 pounds, using 10 pounds per fisherman per day as a reasonable average estimate.

Estimated total landings during August, 1955 to July 31, 1956, of fish in Monroe County, by type of spearfishing.

Type of fisherman	Fisherman days	Average catch man day in lbs.	Total landings in pounds
Non Commercial			
Non club members	5700	5.5 - 13.5	10 57,000
Club members		13	
Commercial	1000	150	150,000
TOTAL	6700	—	207,000

This estimate was obtained by multiplying the total number of spearfishing days of non-commercial fishermen (2850 charter boats + 2850 non-charter boats) by their approximate average catch (10 pounds) and combining this with the commercial spearfishing days (1000) multiplied by their approximate average catch (150 pounds day).

Some of the problems raised in the Florida Keys area by spearfishing result from the fact that the interests of the spearfishermen conflict with the interest of others. Anglers, charter boat operators, commercial fishermen, fishing camp operators, and owners of other businesses such as motels and restaurants have shown concern over this activity.

The problems of most importance to these groups may be biological, economic or social in nature. They are generally related to a certain location and may differ from place to place.

The users of the several gears, while in favor of conservation to insure a maximum catch for their gear, are often reluctant to share the broader view

held by professional conservationists and administrators that the yield should be shared by all legitimate interests.

Fishermen of all kinds generally desire a high catch per unit of effort. The more fish around, other things being equal, the greater is their catch per unit of effort. As long as they compete with similar gear, problems of competition are not usually raised. But when any new fishing method begins to operate it is subject to attack by users of other gears since its operation reduces the catch of all gears. Also, when a fishery is conducted in such a restricted location as a bridge, jetty, or reef, the simultaneous operation of several types of gear obviously does not lead to operation of any one at maximum efficiency.

Under these conditions, in order to maintain or increase their catch per unit of effort, the more powerful group usually seeks to limit or eliminate the less powerful group.

Certain interests claim that spearfishing reduces local fish populations rapidly and that if spearfishing were allowed to continue at its present rate the fish would be so diminished that other interests dependent on them would suffer. Obviously in considering the reduction of fish stocks as a result of fishing pressure there is a question of whether spearfishing or hook and line fishing is more instrumental in reducing the local fish populations. We do not have data on the relative catches of anglers and spearfishermen, nor do we know the condition of any of the stocks of reef fishes.

Some information is available on the movements and behavior of some species found in Bermuda which probably can be applied to the same species in the Florida Keys.

Bardach (1957), in a paper also published in these Proceedings, tagged fish on a small reef (2.47 acres in area) in Bermuda. Nassau grouper (*Epinephalus striatus),* red hind *(E. guttatus)* and some rockfish, *(Mycteroperca)* were the species studied. Some of the recaptures of tagged fish were made after the fish were free about one year, and other tagged individuals were observed repeatedly in the area. Bardach believes that the movements of these fish were not great. He points out, however, that for the Nassau groupers no fish over 6.6 pounds in weight was tagged and that "Nassau groupers of this size are just reaching sexual maturity and many probably move off into deeper water later in their lives." He also says that the rockfish *(Mycteroperca)* do not attain their maximum size in the shallow reef environment. For the red hind (*Epinephalus guttatus*), a small grouper which grows to about three pounds, he found that individuals occur in depths of 50 and 60 fathoms and they were found in fair abundance down to about 30 fathoms. He also states that "the sizes and species composition from deeper traps suggest a greater proportion of large to small seranids, than on the shallow reefs."

For species such as the groupers it may be that much of the stock is at depths which are beyond the usual fishing depths worked by spearfishermen and thus is not generally accessible to this gear. For those individuals living for long periods on the same shallow reef their numbers in these areas would probably be noticeably reduced by fishing pressure of spearfishermen, anglers or commercial gears.

To determine a desirable rate of fishing on these stocks would require biological information on growth, mortality rates, and the habits of these fishes, which is not available.

For many of the migratory species any decline in numbers would not likely be caused principally by the fishing pressure exerted by spearfishermen since other gears are more efficient and account for larger landings.

For example, it is estimated that there were 516,000 fisherman days of fishing by sportsmen in Monroe County in 12 months during 1955 and 1956[1]. If the average catch per fisherman per day is assumed to be three pounds (probably a low estimate) the total sport catch (including spearfishing) would have been about one and a half million pounds of fish. The figure could easily be closer to double this amount.

The commercial catch of finfish (i.e., excluding shrimp, lobsters and other species) in Monroe County from July, 1955, through June, 1956, was 2,473,000 pounds[2].

Hence, it is clear that spearfishing accounts for a small fraction of the fish caught in Monroe County (approximately 207,000 pounds compared to not less than 4,000,000 pounds).

The sociological problem of interference between anglers and spearfishermen exists on the reefs and near bridges, and this becomes more acute as the number of fishermen increases. The potential danger of the speargun as a weapon is another social problem.

The economic question of how commercial fishermen are affected by the sale of speared fish by part-time commercial fishermen and anglers is raised. Some charter boat operators are confronted with an economic problem involving the loss, or the potential loss of their customers, due to an unwillingness of anglers to patronize a locality also patronized by spearfishermen. Or a customer may be lost because he elects to spearfish instead of angle. It is clear that certain businesses in the Keys have suffered due to the activity of spearfishermen, since some anglers are said to have avoided such areas because of their presence. However, other businesses have certainly been increased by their patronage.

No balance sheet can be struck by the author to show whether greater economic harm than good has resulted from the presence of spearfishermen in the Keys, and it is believed that too many intangibles are involved to permit any observer to make a valid judgement on this question. It was evident from the present study that this problem varied in the different areas, even within distances of a few miles.

Methods of Regulation of Spearfishing

There are several possible methods of regulation of spearfishing. It is assumed that it is to be regarded as a legitimate activity. The problem then involves control of spearfishing so that it will not interfere seriously with other fishing activities and will not cause damage to the fish stocks. Methods in force in other parts of the world, or which have been suggested for Florida include the following:

1. Bag limits
2. Species restrictions
3. Closed seasons
4. Gear restrictions
5. Area restrictions

Bag limits:

Bag limits have been suggested as one possible method of regulating spearfishermen. This method presupposes that the catch is too large and that a bag limit would reduce the total take. There is a good possibility that groupers

[1]Appreciation is expressed to Mr. Robert Ellis, who is in charge of the Game Fish Economic Survey being conducted by The Marine Laboratory for the State Board of Conservation, for these preliminary data.

[2]Florida Landings

(including jewfish) have declined in certain localized areas. Other species do not appear to require protection now.

Since other gears fish the same species of fish in this area, it does not appear that any bag limits, if they are introduced, should be placed upon spearfishermen and not others. If increased fishing pressure affects the stocks of fish so that bag limits would seem advisable then spearfishermen and other sport gears should be equally restricted.

Species Restriction:

Another suggested method of regulation (which is used in California) involves prohibiting the landing of certain species of fish. This control is to prevent the depletion of species of fish that are easily caught by the spearfishermen, are not relatively abundant, and are relatively non-migratory. Groupers might fit this description, but so far are reasonably abundant except in certain local areas. Since no biological information of the type necessary to determine if any other species of the Florida fish taken by spearfishermen fit these categories it is deemed unwise to suggest such restriction at this time. In addition such restraint of spearfishing does not aid in the solution of the social and economic problems which were discussed above.

Closed Season:

In general the purpose of closed seasons is to reduce the fishing pressure or to prevent the taking of fish when these are spawning, or very readily available. These restrictions should be passed only after the usefulness of this type has been clearly demonstrated. This has not been shown for any of the species fished by spearfishermen. Social and economic conflicts would likely be heightened by using closed seasons, especially if such a restriction affects anglers and spearfishermen unequally.

Gear Restrictions:

The outlawing of certain types of spearfishing equipment is a method that has been used in Bermuda to regulate spearfishermen. Here spearguns operated by compressed air are banned on the grounds that they are dangerous. However, the air powered speargun is not the most effective gear for skilled spearfishermen and banning of this type of gear would not serve to reduce their catch.

Gear restrictions might be employed when a certain type of gear catches a larger proportion of the stock than the fishery can bear, but the banning of compressed air guns would not serve this purpose.

Area Restrictions:

Finally, it has been suggested that certain areas be set aside where spearfishing is prohibited, while other areas are allotted for the sole use of this type of activity. Area restrictions are in force in Florida at present, of course, with spearfishing being prohibited near piers and jetties, and with the northern end of Monroe County being closed to spearfishing. This latter prohibition is regarded as being too severe; furthermore, no area is given to spearfishing for their exclusive use in return for losing desirable locations.

It appears that some problems of conflict between spearfishing and angling could be at least partially resolved by allocating certain areas for the exclusive use of spearfishermen, at the same time having this gear banned from other areas.

It is suggested that more than one spearfishing "preserve" be established. The northern part of Key Largo would be one suitable area; the exact location should be decided upon after consultation with those groups concerned.

This type of regulation would keep the various groups of fishermen apart and help to eliminate social conflicts. It also might serve to increase the total use of the Florida Keys area by fishermen, thus enhancing the economic status of this area.

The elimination of fishing pressure by spearfishermen in certain areas might help to increase the catches of anglers. On the other hand the establishment of areas exclusively for spearfishing might result in an increase in the total fishing pressure there, and as has been discussed previously, this may lead to a noticeable reduction of fish such as groupers in the area, resulting in lower individual catches by spearfishermen.

Under these circumstances consideration might then be given to the placing of size or bag limits upon the spearfishermen's catch. Continuous observation of the areas would be required to determine the desirability of this.

RECOMMENDATIONS

(1) Spearfishing should be recognized as a legitimate sport activity.
(2) Species restrictions, closed seasons and gear restrictions are not believed to be useful in solving the problems of spearfishing in Monroe County.
(3) Bag limits are not recommended at present.
(4) Area restrictions, prohibiting spearfishing in certain areas, but allowing this type of fishing to have the exclusive use of other areas, is suggested as a possible control.
(5) Night spearfishing with an artificial light should be banned.
(6) Sale of speared fish should be banned, as should sale of all fish caught by sport anglers.
(7) Spearfishermen should be obliged to secure a license from the State Board of Conservation, provided other types of sport fishermen are also licensed.
(8) The information needed to decide whether conservation is being served is lacking. Catch data and biological information concerning the local habitats and the biology of the fishes found there is essential. To gather and analyze basic data would require lengthy research, but it should be started.

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Progress of Recovery of the Commercial Sponge Beds of Florida

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This report of progress of recovery of the commercial sponge beds of Florida is a phase of the over-all investigation of the Florida commercial sponges being carried out by The Marine Laboratory for the Fish and Wildlife Service through Saltonstall-Kennedy funds. The present paper is a progress report of the work under way.

[1]Contribution No. 180, The Marine Laboratory, University of Miami.

This problem of recovery of the sponge beds is discussed under the following headings:

1. Historical background.
2. Present distribution of the sponges in the upper Gulf.
3. Sponge productivity.
4. Growth rate of the sponges.
5. Present distribution related to ocean currents.
6. Factors affecting distribution.
7. Probable distribution in five and ten years.

1. Historical Background.

Through the years 1900 to 1938 an average of 350,000 pounds of sponges were taken per year. In late 1938 a disease or blight struck the beds killing off large quantities of the wool, grass, and yellow sponges, the three principal commercial species. Production during the next eight years was maintained at a level of about one-third of the previous average, but only as a result of a substantial increase of about 50 per cent in the sponging fleet. By 1946 the number of boats working the beds was 191, of which 75 were diving boats. The remarkable increase in the price of sponges, from $2.00 per pound to as much as $30.00 per pound during the war years, was responsible for this fishing pressure. At the same time, the number of pounds taken by each boat (the return per unit effort) was reduced from a high of 6,900 pounds in 1936 to a low of 1,200 in 1947. In 1947 the sponge beds were again attacked by a disease, which this time was most effective in destroying the wool sponges, leaving the grass and yellow sponges relatively unaffected. These species were later destroyed by 1951. In 1951 the sponge fleet had reached a low ebb of only two diving boats and 26 hook boats. Production during this year was less than three per cent of both the maximum value of 1944 and maximum take of 1936. According to reports received, commercial sponges at this time were to be found only in the shallow coastal waters of less than five fathoms in restricted areas along the coast.

2. Present Distribution.

One of the necessary phases in determining the distribution of the sponges has been a survey of the sponging grounds. On the deep water survey trip made in July of this year (1956) the services of regular sponge divers and a sponge diving boat were used. Each station of the trip consisted of one or more dives on a sponge bar to determine the presence of commercial sponges in depths from eight to seventeen fathoms. A collection of a representative group of the local plants and animals was made at the same time. On this trip the primary purpose was to establish the outer limits of the growth of the wool sponges. Two other shallow water survey trips were made in the fall of 1955 in one and one-half to nine fathoms of water. In all, 88 stations were established in the area from Tampa Bay to Carrabelle, comprising well over 100 dives. The shallow water survey trips were made aboard a small 30 foot cabin cruiser with the use of light weight diving equipment, consisting of a foam neoprene suit and Desco diving mask with the air supplied to the diver by a small compressor. The diving on these trips was done by the present investigator.

From the survey stations and additional reliable information from the diving boats, the present distribution of wool sponges in the northern portion of the Gulf appears to be limited to less than 10 fathoms. The most important work-

ing beds lie on the west and north of Anclote Key and in the areas between Cedar Keys and the Steinhatchee River and in the Rock Island area. In no area are the sponges growing in commercial quantity in water deeper than eight or nine fathoms and the most productvie areas are in water less than six fathoms.

The 1955 take by the hook boats in depths from one to three and a half fathoms of water was equal to that of the diving boats in three and a half to seven fathoms of water. Catch per unit effort is still low, approximately 1,800 pounds per year per boat, which indicates overfishing is taking place even with a very reduced sponging fleet.

3. Sponge Productivity.

The eggs in a sponge are concentrated in the lower two thirds with very few eggs developing near the periphery. (Fig. 1.)

Very little has been written about sperm transfer in the sponge. It is known that sperm are produced in quantity by one sponge, released into the water to be picked up by another from the in-current water during the normal feeding process. In a very recent paper by Lord Rothschild of Cambridge, England, on "Unorthodox Methods of Sperm Transfer," he states that in the sponges examined, the sperm is taken up by one of the choanocytes or flagellated collared cells much in the same way as a particle of food. He suggests that the choanocyte picking up the spermatozoon is always the one closest to an egg cell or ovum. The choanocyte, on ingesting the spermatozoon, regresses or changes to an amoebocyte cell. The egg cell acquires both this cell and a nurse cell and, after enlargement of the ovum, the spermatozoon is transferred from the regressed choanocyte to complete the fertilization process. This process suggests that an ovum of the sponge will not enlarge unless triggered by the presence of a sperm in an adjacent sperm-holding cell, or in other words that sponge eggs are not visible to the naked eye unless sperm have been picked up from the water and have fertilized the ova.

It has been observed in the field that where wool sponges are widely scattered over the bottom the mature sponges either do not produce eggs or the number of eggs and larvae produced is very small. If the fertilization process just described, or a similar process, is the one used by the wool sponges it would explain the observed phenomenal lack of eggs in sponges in areas where the density of the population is light and the heavy production of eggs and larvae in mature sponges where the population density is high.

On the assumption that wool sponges are incapable of self fertilization, on the evidence available we can state that the density of sponges is a very important factor in productivity of the sponge bars.

When mature, the egg darkens in color and develops a circle or crown of cilia at one end and is then released into the water, where it is active for several days while being carried about by the ocean currents.

In a microscopic examination of the interior of a wool sponge the eggs can be discerned as small white spots about 0.5 mm (1/50th of an inch) in size, the larvae appearing darker in color. In the upper part of the Gulf only those sponges with a diameter of more than five and a half inches have been found to be producing eggs. (Fig. 2.)

Closer examination of the egg extracted from the sponge shows that the

FIGURE 1. Cross section of a wool sponge six inches in diameter. The sponge eggs are seen as small white dots throughout the flesh. The large canal at the left base of the sponge was made by a sponge crab, the others are either incurrent or excurrent canals of normal size. This sponge carried about 60,000 eggs. (x 2/3)

end on which the cilia will develop is again darker in color with the ring of cilia being readily identified.

4. Growth Rate of Sponge.

The third essential factor in estimating the progress of recovery of the sponge beds is establishment of the growth rate. The field work on this phase of the study has consisted of tagging and measuring sponges on productive

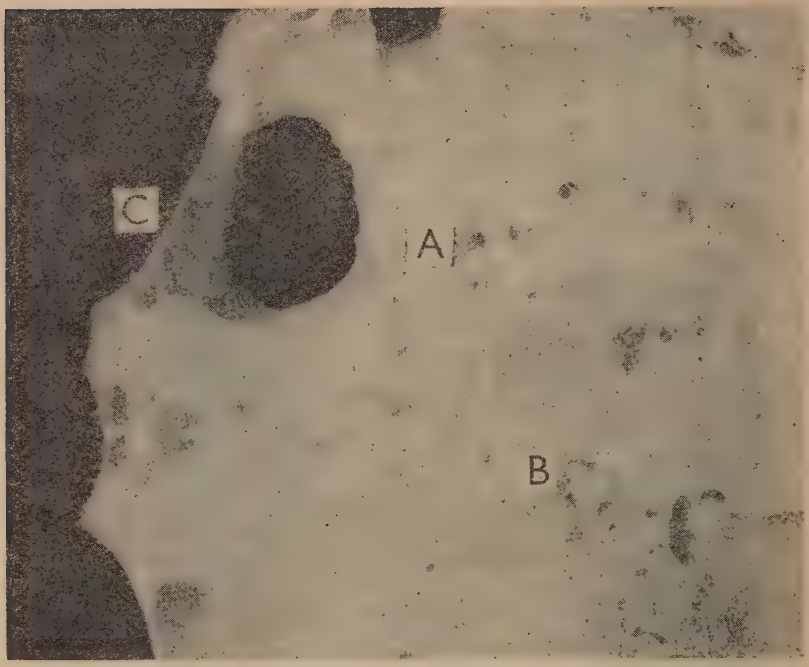

FIGURE 2. A magnified section of a mature sponge. The eggs to the right of A are fertilized growing eggs while to the right of B an egg has reached the larval stage and become darker in color. At C a section of the so called sponge "skin" covers over a subdermal canal. (x 50)

sponge bars. The sponge is tagged by wiring it to a code numbered brick and measuring its three dimensions with a measuring device, a modified sliding square. These data were then recorded on a piece of sanded plastic with an ordinary lead pencil. A number of wool, grass and yellow sponges have been tagged and measured.

From the data on growth rate collected to date, a growth curve for wool sponges has been compiled.

In the accompanying diagram the volumetric rate of increase, with growth obtained during this study, is compared with that determined by H. F. Moore and reported in the Bulletin of the Bureau of Fisheries in 1908. His four year's experiment was with the growth of cultivated sponges, starting with cuttings of about four cubic inches. For ease of understanding, the growth in volume is shown on the left hand side of the chart and in diameter on the right hand side of the chart. Moore determined the annual increase in diameter to be between one and 1.2 inches per year, with the solid line B representing an increase of about one inch per year found at Anclote Key, an island just seaward of Tarpon Springs. Dotted line A represents a rate of growth of about 1.25 inches per year, or just slightly above the maximum growth rate Moore found in his experimentation at Anclote Key. (Fig. 3.)

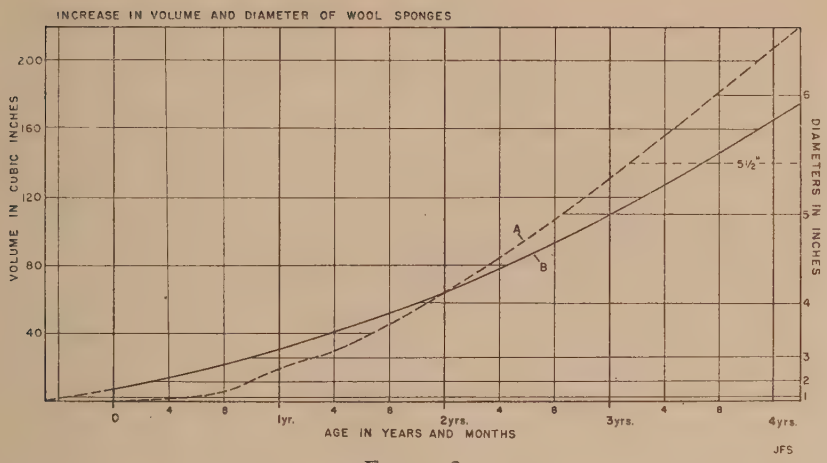

FIGURE 3.

5. Present Distribution Related To Ocean Currents.

The final factor essential to recovery of the sponge beds is the rate and direction of the distribution of sponge larvae to bring about new sponge growth. Considerable assistance in this phase of the work has been obtained from members of the Red Tide Project at The Marine Laboratory, who have been working on the current pattern of the Gulf, off the West Coast of Florida. Both the oceanographers and this author were agreeably surprised to find that the present extensions of the sponging areas fit very closely into the preliminary determination of the pattern of the currents. The most important current to sponge dispersal is a northward moving shoreward current. Just north of Tampa Bay the complete lack of sponges can be attributed to the lack of productive sponge beds upcurrent from the area and a reversed and shoreward moving current of water that prevents movement of the sponge larvae seaward. Where eddy currents move seaward along the coast at three points the distribution of the sponges is seen to be extended seaward. In the extreme northern part of the sponging area the elongated shorewise eddy and current is extending the distribution at the most rapid rate and this is reflected in the size distribution of the wool sponges in this area, with the smallest sponges being found at the leading edge of distribution. (Fig. 4.)

6. Factors Affecting Distribution.

Summarizing the factors affecting the rate of distribution we find:

(1) The water currents are of two kinds, permanent and tidal. The maximum rate of flow of the permanent current along the shore has been determined to be five miles per day, with the seaward eddy currents estimated at one mile per day. Tidal currents in the northern Gulf have been recorded at one half a knot. While the general trend of the permanent currents are northward or seaward, the tidal currents are generally running back and forth at right angles to the shore.

(2) It requires at least three years before sponges begin to produce eggs and larvae with the average sponge reaching maturity at an age of four years.

(3) The life span of the swimming larval form appears to be several days

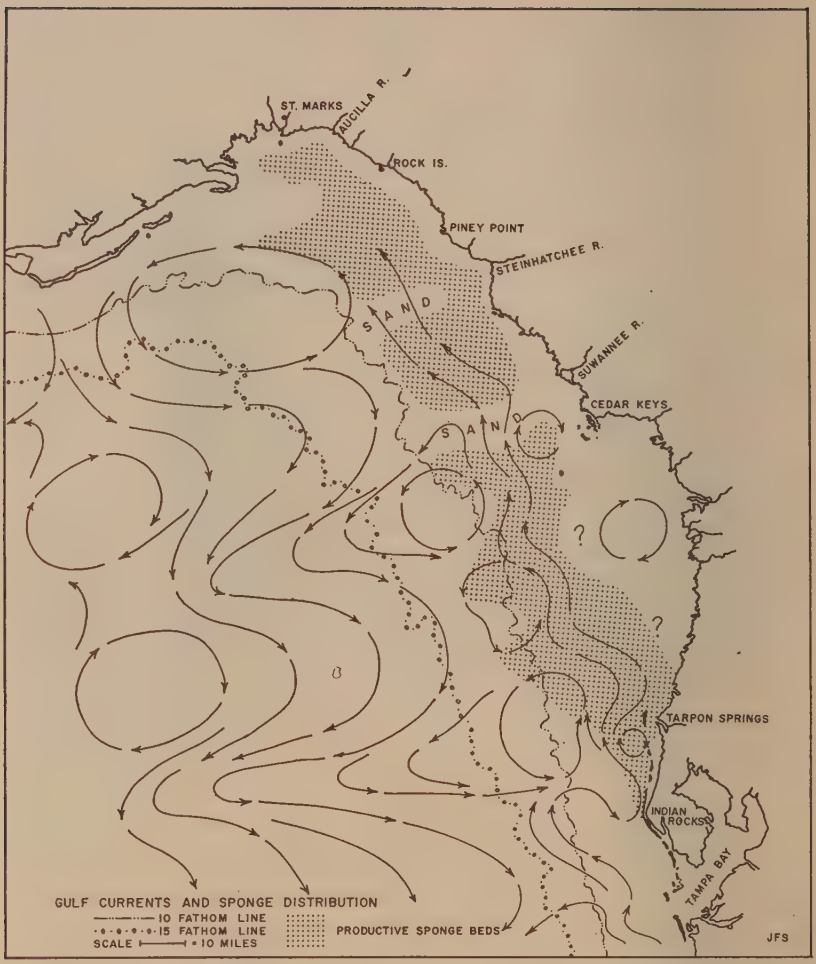

FIGURE 4. This chart shows the present distribution of the sponge beds in relation to the water currents of the upper Gulf. The current pattern shown is a preliminary determination by members of the Red Tide Project at The Marine Laboratory, University of Miami.

and for the sake of clarity we may assume that the maximum life span is four days.

Translating this into diagrammatic form and using the maximum values, a four day life span for the larval form and a current of five miles per day, the maximum distance a larva can be transported is 20 miles. Since it will require about four years for the average sponge to come into full egg productivity the maximum yearly advance of sponge distribution is about five miles.

7. Probable Distribution in 5 and 10 Years.

Using this knowledge and the knowledge of current direction and rate of flow we are in a position to make an estimate as to the probable distribution of the sponges five and ten years hence. The most rapid rate of distribution of the wool sponges can be expected along the path of the shore and eddy current in the north, which within a 10 year period should spread the sponges to the 12 and 13 fathom depths in the area south of Carrabelle, where the sponge beds were very productive and a considerable amount of the bottom is considered to be good sponge bottom. The area next in importance is that on either side of the quartz sand strip extending from the mouth of the Suwannee River in a WSW direction. A third Gulfward distribution is taking place west of Anclote Key and Tarpon Springs.

What value this extension of the sponging area will be is difficult to evaluate at the present time. The men presently engaged in the offshore diving are older divers who limit themselves to six and seven fathoms of depth. Since, with the exception of an area south of St. Marks and Carrabelle, the expected new grounds will be into depths greater than seven fathoms they will not be of significant value to the industry.

The greatest value of any extension in the grounds will be in spreading the fishing pressure over a greater area. Larger sponges will then be allowed to grow on all the beds, which, by increasing natural spawning, will bring about an increased density of the sponge population. This increased population and density of population, if used wisely; will result in an increased take per unit of effort, bringing about a greater and sorely needed financial return to the individual sponger engaged in this industry.

DISCUSSION

Biological Session

Discussion Leader: DAVID WALLACE

Discussion Panel: EDWIN S. IVERSEN, R. WINSTON MENZEL, ARTHUR MARSHALL, RICHARD ROBINS

Scientific Investigations of the Atlantic Coast Menhaden

FRED JUNE

Q. Olcott: Are biologists agreed on the reason for the disappearance of the menhaden from Maine?

A. June: The hypothesis is that the disappearance of the fish was caused by a general cooling of the waters there in the early 1870's, and that spawning and survival were unsuccessful due to this cooling. We are now experiencing a gradual warming in this area, and the northern population is again building up.

Mowbray (Comment): You have mentioned the occurrence of schooling menhaden at sub-surface depths. A recent investigation of mine pointed out the occurrence of schooling fish at about the 90-100 foot depth off Bermuda. Since menhaden are entirely plankton feeders, this apparent depth preference may be of some

value to the industry in locating fish by finding the depth at which plankton is most abundant.

Bullis (Comment): This depth may represent the level of the thermocline. In the Gulf of Mexico the "normal" range of the themocline falls near the 100 foot mark and to temperature sensitive organisms this might be an important barrier.

June (Comment): When menhaden were being caught below the surface, a companion vessel was taking bathythermograph readings, and we found that the thermocline and the fish occurred at the same depth.

Studies on the Life History of Spotted Sea Trout, Cynoscion nebulosus (C. & V.)

Durbin Tabb

Q. Iversen: What is known of the temperature tolerances of the spotted weakfish?

A. Tabb: There are few accurate records of the effects of temperature on the behavior of this species, but from personal observations and a search of the literature, I suspect that 48°F. is near the minimum temperature tolerated.

Q. Robins: What can you tell us about the effects of dredging and spoil disposal as it relates to the various stages of the life history that you have mentioned?

A. Tabb: The apparent value of the dredged channels to wintering and spawning trout has been a striking feature of this study. Dredging has been carried out for many years in the Indian and Banana rivers and fishing has not appeared to suffer. The building of the inter-coastal waterway, with the resulting deep channel and parallel spoil bank islands created deeps and shallows for spawning and feeding which formerly were not available. The immediate effects of dredging, particularly during spawning time, may be harmful but I suspect that the long run effects are not detrimental unless the spoil is not dumped judiciously.

Q. Marshall: What do you mean by judicious dumping of spoil?

A. Tabb: The spoil from large dredging operations, such as that involved in creating the inter-coastal waterway, may create shallow feeding areas in water which formerly was too deep to support marine grasses. This is favorable from the standpoint of the feeding juvenile spotted sea trout, as well as that of mullet and other species. Another aspect is the chilling of the water which takes place by wind mixing, due to altered current patterns. The lagoons in the study area lie in a north-south direction and the average depth is small. When the strong winter winds sweep in with rapid drops in temperature, the mixing and chilling of the river water is rapid and sometimes fatal to the trout, since the fish often have a great distance to travel before the shelter of warmer

ocean water is reached. Spoil banks or islands slow down the force of the wind and dredged channels provide the deep water which the fish seek for protection from cold. However, spoil banks can create poor water circulation and stagnation by damming off bays.

Q. Stein: Do you know the spawning habits of the spotted sea trout?

A. Tabb: This species apparently spawns in the deepest part of the channels. Eggs from plankton tows were always most numerous in areas of deep water. Small spotted sea trout can always be taken in channels until they reach a length of three to four inches. At this time, they become stronger swimmers, form into schools and spread out over the "grass flats." Studies of cell cleavage and studies of numbers of eggs available point to spawning from midnight till dawn.

Q. Clark: What causes differences in spotting in this species?

A. Tabb: This is probably just an example of aberrant color and pattern development. Red fish, which normally have but one spot at the root of the tail, often are found to have many spots. Often the spotted sea trout taken in the ocean will be quite pale until they are placed in brackish water. This causes the spotting to appear quickly.

Q. Marshall: What is the relationship between salinity and the occurrence of adult spotted sea trout in the Indian and Banana river systems?

A. Tabb: The adults occur commonly in water of eight to thirty-five parts per thousand, and are adversely affected by anything higher or lower.

Q. Menzel: Do you have information concerning sex ratio at various sizes and ages and differences in growth rate between sexes?

A. Tabb: In the zero year class the males appear to outnumber the females by about nine to one. After that the ratio of males to females drops until the fifth year when there are very few males remaining. The growth rate of males and females of the zero year class is about equal; however, the females of year class one through five exhibit a more rapid increase than do the males. The females were all mature by the time they had reached 18 inches total length while males were all mature by the time they had reached 12 inches total length.

Field and Laboratory Observations on the Growth of Some Bermuda Reef Fishes

JOHN E. BARDACH AND DAVID W. MENZEL

Q. Menzel: How did you catch your fish?

A. Bardach: In traps; diving equipment was used in observation and counting.

Q. Robins: Have you experienced any cases where a population was completely or partially depleted on a segment of reef? If so, have you observed that the fishes were replaced either by an

increase in growth rate of the young fishes or by an immigration of fishes from neighboring regions?

A. Bardach: We have not observed such depletion, but we have some evidence of movement between adjacent areas. We tagged fish on two adjacent reefs about 200 yards apart and about one hectare in size, and released them on the other reef. We then observed these fish for about six weeks, and found that groupers had a definite and strong homing tendency, while some of the predominantly herbivorous fish such as doctor fish and angel fish did not return to their home reefs but established themselves on the new reefs.

Q. Voss: In your aquarium experiments did the fish die or did you release them after the 20 to 30 days?

A. Bardach: They developed fungus growths so we released them.

Q. Voss: Were the reef areas that you examined separated by sand or grassy bottom or were they all part of the same reef?

A. Bardach: The reefs we studied most intensively were separated by sandy bottom at about fifty feet depth. However, we did make some comparative studies on unbroken larger reef areas, and we found that the isolated reefs apparently support a much larger population than the unbroken reef areas. Reasons for this seem to be the much greater amount of vertical wall space available, and the large association of gray snappers and grunts that are found in such situations.

Q. Mowbray: Was there any noticeable change in the composition of a population, particularly of larger fish, on a reef due to movements of individuals?

A. Bardach: Most of the serranids remain fairly stationary and associated with the same reefs, but over a period of a year or two there was considerable movement. It is likely that some of the rockfish of the genus *Mycteroperca* will grow to large sizes in the shallow reef environment, but this particular reef we studied was not the home base of any such animal. I have seen large specimens of *Mycteroperca* in about the same depth, but the Nassau grouper, for instance, does not seem to grow to sexual maturity in the shallow environment. I cannot say whether the individuals move out to deeper water or if there is a heavy mortality in the shallow environment.

Q. Mowbray: What kind of tags did you use?

A. Bardach: We used various kinds of tags, starting with the plastic streamer tags tied with nylon cord. These were affixed either just anterior or posterior to the dorsal fin. Some of those fish which move in and out of holes and crevices were tearing out tags. In the groupers, at least, we had a tag loss of about 30 per cent during the first three or four weeks. We switched to metal jaw tags but found that there was a decline in growth rate.

The fish on this particular reef were so tame after a while, that instead of hiding they came out to be counted. You could actually approach almost any fish to read the number

on his tag. In that manner we collected information on movements and habits of the fish.

Q. Stein: Did you notice if the snapper populations on the reef stayed there?

A. Bardach: The snappers that occur from about 50 feet, or shallower, were all gray snappers. We were able to observe several schools of these snappers on the reef for over a year. We caught several individuals out of each school and tagged them. The individuals rejoined their schools. During the day fish would cruise around the reefs and occasionally come up on the top of the reef, but more often would be found about half depth or even lower. They would be moving slowly, apparently without feeding. We caught fish on the other reefs and examined their stomachs, but I haven't seen any gray snapper stomach that was full during the day. Long and Hildebrand report the schools break up at night to feed, but I haven't done any night diving.

Problems Raised by Spearfishing in Florida Waters

JAMES MURDOCK

Q. Marshall: Anglers think that spearfishing depletes stocks which are local to a given reef, jetty or other such feature. What have the spearfishermen themselves to say on this matter?

A. Murdock: Spearfishermen have told me that there is a limit to the number of fish, and particularly large fish, that they can find. This is true of red snappers or any other fishes. Whether this fact is due to spearfishing activities is another matter.

Q. Marshall: Are the fish caught by spearfishermen of a different average size than those caught by anglers?

A. Murdock: Spearfishing is a more selective method of fishing than angling, but on the average there appears to be little difference. Occasionally spearfishermen land exceptionally large fish of 300 to 400 pounds. This size of fish is not usually landed by anglers, although commercial hook and line fishermen used to bring a few of them into Key West.

Q. Bardach: How much waste of fish takes place among spearfishermen who fish for sport? Also are speared fish readily saleable?

A. Murdock: The spearfisherman who sells his fish usually sells them to a restaurant, where after being dressed, there is no evidence of how they were caught. I have seen more waste by anglers than I have seen by spearfishermen. Spearfishermen who go on weekend trips often have a low catch. The reason his catch is low in many instances is because that is all the fish he desires to take home to consume or give to a friend.

Clark (Comment): There is considerable difference in the wastage of fish between the novice spearfisherman, as compared to the more experienced spearfisherman. The more spearfishing you do the more you appreciate the beauty of the fishes and you don't spear every fish that you see. In time spearfishermen turn into skindivers, they take up photography and they don't spear fish indiscriminately.

Q. Clark: When I first heard a proposal that spearfishing should be limited to the day-light hours, I thought it was a joke. The only extensive spearfishing I've seen at night has not been of the usual kind, under water, but has been conducted by wading in knee deep water, or from a boat where you can throw the spear down into the water. Could you tell me something more about the methods used by commercial spearfishermen who go out at night and get several hundred pounds of fish? Are they completely submerged and do they use the methods of skindivers as we think of them in general?

A. Voss: The night spearfishing that was carried out at Palm Beach was done by groups of people who used electric lights below the water. Snook around these inlets were lying under the rocks in areas where there was only a slight current. They lay in heavy concentrations, facing the current. They were from 12 to about 20 pounds in size. One person would spot them with the light and two or three others would shoot them while they lay there, held like a deer when he is spotted. This was extremely destructive. At Ft. Lauderdale, charterboatmen have for many years fished for groupers and snappers on a certain reef in about 85 feet of water. Then spearfishermen found it and began catching out the big fish. The charterboatmen then moved out to the next reef, which was in 150 feet of water. This depth effectively stopped any spearfishing and now charterboatmen are getting bigger fish than they've ever gotten and more of them. They are satisfied and there is no quarrel between the groups. I have been asked to write to the A.A.U. asking them to outlaw spearfishing as not being a sport. It is evident to me that it is certainly a sport and the conflict is a matter of economic competition.

Q. Mowbray: I would like to compliment Mr. Murdock on the most impartial presentation of the question of spearfishing that I have ever heard; I agree with him from every angle. The problem here is similar to the one in Bermuda and it is as much psycological as it is anything else. We have regulated spearfishing in Bermuda by a gear restriction. Numerous people in the Islands had for years engaged in spearfishing by the use of a straight spear propelled entirely by the hand. Then the spear gun came into being and there were several accidents. The police decided that these guns came under the firearm act and that automatically banned them from public sale. Spearfishing is still permitted by hand spear. The average spearfisherman can get all the fish he will ever require for eating purposes by that method. As a matter of fact, experienced individuals can outfish a man with a gun by three or four to one. We have also barred the use of the aqualung or other devices for spearfishing. Finally, we have a bag limit, which is two individual specimens of each species per day, plus three lobsters.

Progressive Recovery of the Commercial Sponge Grounds of Florida

JOHN F. STORR

Q. Menzel: What are the possibilities of providing cultch for sponge?

A. Storr: There is enough rock to provide a settling surface for larval sponges without having to provide artificial cultch. The scattering of cultch would be impractical anyway since the sponges should not be closer than a yard apart.

Q. Menzel: Do you expect a recurrence of the sponge disease and are studies being conducted which might point out methods of controlling the disease?

A. Storr: The sponge disease has hit in many places during the past 50 years and may be expected again. Control of the disease is difficult because of the great areas involved. Usually, the density of the sponges in producing areas is so great that, even after disease hits, enough are left for seeding and it is just a matter of time till the area is back to normal. The lack of recovery after 1938 in the Florida beds was due, I believe, to the intense fishing pressure.

Q. Menzel: Is there a possibility of transplanting sponges into the area?

A. Storr: The possibility is there, but what the practical value of it would be is another question.

Q. Marshall: Could you give a resumé of sponging activities in the Ten Thousand Islands area and your estimate of future potentials for such activities in this area?

A. Storr: Sponges were first discovered in that area about 1935. They were affected by disease during 1938 but have now recovered considerably. According to reports of the fishermen, the greatest number of sponges are being taken in the Cape Sable area west of Shark River. They are growing so thickly that the take per day is about 1,000 sponges. The difficulty of sponging in the area is the turbidity of the water which makes sponging difficult. Under clear conditions during the early winter months the take is good. They say that the number of small sponges is tremendous and that productivity during the coming year should be excellent.

Q. Robins: Would it be possible to predict, by knowing the temperature of the water, when a certain sponge bed would not be able to make up in growth the amount that had been lost during the spawning period and due to cold weather?

A. Storr: You are referring to the fact that a sudden drop in temperature over a short period of time causes the sponges to withdraw the living material, leaving the sponging fibers exposed at the edges. This has also been observed in the field. We could only predict the extent of the withdrawal by further experiments.

Q. Clark: What do you think is the survival of sponges to about 1½ inches of size?

A. Storr: I believe that about one out of every two or three thousand

larvae are able to attach to the bottom and grow to that size. It is difficult to estimate what the natural mortality of the larger sponges would be because of the fishing that takes place. However, in areas where fishing does not take place the ratio of sponges of less than three inches in size to those about seven inches in size was about three to one. Apparently the rate of mortality is high, with only about 70 per cent of the sponges growing to maturity.

Q. Farley: What is the economic outlook for the sponge industry?

A. Storr: There is a rather poor economic outlook for the sponge industry. The reason for this is that the return per unit of effort has been low and as soon as the sponges begin to return the number of fishermen increases beyond the number that the beds can support. They should be encouraged not to increase their effort and to allow these sponges to return to their normal density and then the fishermen's return would increase by three to four fold. At the present time the average share of a deckhand, who gets one of the 12 shares of the boat, is about $600 to $700 annually, that is for the 100-150 days a year that he spends on the boat. Despite all this there is a gradual increase in the productivity of the beds and the price of sponges is staying up to around $7.20 a pound on the average so there is a good possibility that this industry could come back.

Wallace (Comment): I believe that the potential for natural sponges in the United States is good, in spite of the condition which existed in Florida since 1946. During the period from 1946 up to the present time the sponge supply has come from the Mediterranean and Cuba. The market has taken about as many sponges during that period as it was formerly taking from the Florida Coast up until 1946. I believe that the domestic industry can regain that market if they can produce at a level which will fill the needs of the market and on a fairly consistent basis. The fact that the Bahamas have this year opened their beds for the first time since 1939 and had a tremendous demand for their sponges, even though they had not been in the market at all for that period, is an indication of the demand for good quality natural sponges. The natural sponges must be of good quality to compete, but the potential is there for a very important advantage for the people on the Florida west coast.

Q. Voss: Is the larvae you speak about as being in the planktonic stage for about four days the sheepswool sponge larvae or that of some other species?

A. Storr: From the literature I gather that it is the sheepswool larvae. The reference is that they spend several days in the plankton state and I have taken four days to be the maximum length of survival. It may be that the larvae live for a longer period of time, but this has not been studied.

Q. Voss: Would you care to comment on the fact that so many of the sponge bars are below the level of the general stretch of bottom?

A. Storr: I assume that over the rocky bars the wave action is turned into turbulent action and the silt is put into suspension over the bars and carried away. Thus these bars could be maintained at those lower levels without being silted over.

Q. Voss: Can we get divers to work in the deeper areas after sponges become established there?

A. Storr: When these new beds are open in a few years they will not be able to be worked except by younger divers. There is controversy at Tarpon Springs about the advisibility of bringing over young Greek sponge divers to work these beds.

Q. Mrs. Voss: Does the growth rate of sponges differ in the various areas?

A. Storr: Yes, quite remarkably. At Sandy Key the growth rate was found by Moore to be 0.8 inches while generally it was 1-1.2 inches per year at Anclote Key. The lower growth rate at Sandy Key was attributed to the fact that there was less current action and less food. My observations seem to indicate that the growth rate is higher in shallow areas where current flow is greater, but the quality of the sponges produced in these areas is not as good as those grown in deeper water. With slower growth the sponge is more solid and of better quality.

Q. Williams: Has the sponge disease been recorded in other parts of the world? Do sponge divers encounter difficulty with sharks or barracuda?

A. Storr: I do not have reports of sponge diseases in the Mediterranean. They might have some diseases, but the effects have not been serious. The divers are sometimes bothered by sharks and barracuda, but not to a great extent. I have been attacked once by a barracuda, but that was after it had been irritated. The other diver had worn white shoes, which excited the barracuda. But I don't believe that many of these animals will attack you unless you excite them first.

Q. Bardach: Have very large cubic footage aqualung units been tried by any of the divers?

A. Storr: No, they haven't. My own inclination about using them is that they would be uneconomical. I believe that light weight diving equipment, such as I have, would be useful.

Q. Wallace: Are the possibilities for sponge farming available in the Gulf of Mexico?

A. Storr: Sponge farming could be carried on very successfully in the Gulf of Mexico, from the biological point of view. From the sociological point of view it is another question entirely and whether you can supervise these beds sufficiently and make sure that no one destroys these sponges I don't know.

FRIDAY—NOVEMBER 30

Chairman—F. G. WALTON SMITH, *Director, The Marine Laboratory, University of Miami, Coral Gables, Florida*

The Present Situation in the Fishing Industry of Cuba

JOSE A. SUAREZ CAABRO

Universidad de Villanueva y Academia Nacional de Patrones Havana, Cuba

THE PRESENT situation in the fishing industry of Cuba is almost the same as ten years ago. According to recent statistics there are 13,000 fishermen on the whole Island, which represents 0.2 per cent of the total population of Cuba. Furthermore, there are about 10,000 shore workers employed in processing and transport of fishing products.

It is estimated that the annual production of fish and shellfish in Cuba is around 40 million pounds, which are landed at 44 fishing ports. Of this amount, 11 million pounds (29 per cent of the total catch) arrive in Havana. Other main fishing centers are Batabano with 3.5 million pounds, Manzanillo with 2.5 and Santa Cruz del Sur with two million pounds. The annual per capita of fish consumption in Cuba is very low, not exceeding eight pounds.

Today no fishery research is undertaken in Cuba. In June, 1955, the Fisheries Research Center (Centro de Investigaciones Pesqueras), at Baracoa Beach, 35 miles from Havana, was closed. Later, in November, 1955, the Cuban Government created a new agency named National Institute of Fishery (Instituto Nacional de la Pesca). This department, with an extremely limited budget, is charged with the responsibility for study and research concerning the fishing industry, and is expected to begin research soon.

Cuban fishermen are hard workers and they learn easily any modern fishing technique. However, their educational level is very low and for this reason it is difficult to advise them by means of leaflets or similar written instructions. One of our main troubles is lack of fishing skippers with enough nautical knowledge for good sailing and effective use of fishing gear.

To improve the instruction of skippers the Cuban Navy has created the National Training School for Skippers (Academia Nacional de Patrones) with branches at most important fishing ports. They also have traveling teachers who weekly visit fishing centers without schools. Sometimes those teachers themselves teach fishermen to read and write.

The curriculum includes navigation, marine geography, meteorology, oceanography, seamanship, fishing gear and methods, marine laws and signal codes. The length of these courses is eighty hours, distributed weekly through a period of nine months. To obtain a certificate of First Class Skipper, students must have worked aboard a fishing vessel for 3,000 nautical miles out of territorial waters. To get a certificate of Second Class Skipper three months sailing on Cuban waters is required.

Useful results have come from the work of the National Training School for Skippers. This year the government of our neighbor, the Republic of Haiti, rented a tuna fishing vessel with its complete crew from a Cuban fishing com-

pany. They went to that country in order to teach fishermen of Haiti to catch bonito in the Caribbean Sea with pole and line, using live bait. In addition, fishermen graduated at these schools for skippers have established successful shrimp fisheries in the southeast area of Cuba, employing otter trawls and modern vessels.

Cuba has about 7,000 fishing boats, but only seven per cent of the total are motor-driven and 93 per cent are sail-propelled. For this reason one of our greatest difficulties is lack of motors in the fishing fleets. Furthermore, many of them are less than 15 tons capacity. These two factors affect Cuban fishing industry, limiting the fisheries to the narrow insular shelf close to land.

At the present time our best fishing vessels are those used for deep water fishing in Mexican waters. Almost all these fishing boats are more than 15 tons capacity, with an average length of 90 feet, a beam of 14 feet and draft of 10 feet. Most of them are motor-driven and carry ice to preserve the fish, but others are sailed-propelled and use live wells to transport the fish. Starting in 1945, the fishing fleet has been improved gradually, installing radiotelephone and echosounding apparatus. Today a great number of sail-propelled boats have been converted to motor driven ones.

The live well vessels have a lot of trouble when they arrive in port. Sometimes when the Havana market is full of fish they have to stay out of port for several days waiting for a chance to land their fish. These boats do not dock in Havana harbor because they are afraid to lose thousands of pounds of fish by means of pollution of sea water. Furthermore, lack of motors in this type of fishing vessel makes their trips longer.

Another common type of fishing vessel in Cuba is the tuna fishing boat. It is a modified sloop with a gaff-rigged main sail and a flying jib, equipped with a live well tank for carrying live bait (manjua) and ice boxes of 10,000 to 15,000 pounds of fish capacity. The average size of Cuban tuna fishing vessels is 50 feet in length, with 14 foot beam and 3½ foot draft. They usually have a 60 to 110 H.P. engine. Actually some of those boats have been improved with installation of radiotelephone equipment and better accommodations for the crew.

Since 1953, the trawler, a new kind of fishing vessel in Cuban fisheries, has been introduced. Most of them were bought in Gulf ports of the United States, and today Cuban fishermen commonly use trawlers for catching shrimp.

The Shrimp Fishery

During the last three years there has been a great development in the shrimp industry in Cuba. There are two fishing methods used to catch shrimp: the old system with cast net, employed by poor fishermen, mainly at Cienfuegos, Tunas de Zaza, Jucaro and Manzanillo, and otter trawls used to catch large quantities of this crustacean at Santa Cruz, del Sur, on the southeast coast of Cuba, and at Dry Tortugas, Florida.

Shrimp catches with cast nets are low and this can be justified only on rocky bottoms where an otter trawl could not be utilized. The total catch from this type of gear is sold on the inland Cuban market. Almost the whole catch consists of pink shrimp *Penaeus duorarum* and white shrimp *P. schmitti*.

The otter trawl is employed by two Cuban fishing fleets. One operates at Dry Tortugas, Florida and lands its production at Havana; the other is fishing on the southeast of the Island and lands shrimp at Santa Cruz del Sur. This latter fishing center is the most important shrimp landing port in Cuba. There are about 20 shrimp trawlers there, with crews of three or four men each.

These vessels spend from three to five days at sea, fishing day and night. A new freezing plant has been established there, which exports frozen shrimp directly to the United States. Since January of this year, the Cuban Government has maintained a cold-storage house for fish and shellfish at Santa Cruz del Sur.

In 1955, Cuba exported to the United States 82,357 pounds of fresh shrimp, with a value of $27,889.

During the first six months of 1956, the landings of shrimp at Santa Cruz del Sur were:

January	71,267	pounds (heads on)
February	106,115	„
March	101,101	„
April	108,106	„
May	180,515	„
June	182,265	„
Total	749,369	„

The average price paid to fishermen at Santa Cruz del Sur has been 23 cents per pound, heads on and 37 cents per pound, heads off.

From May, 1955, to June, 1956, there were 28 Cuban shrimp fishing vessels working at Dry Tortugas and landing shrimp at Havana. The average crew of those boats was four to five men. They made a total of 180 trips during a year. The average number of days at sea was about 15, with 10 nights of effective fishing (about 12 working hours per day). In the 12 months from May, 1955, to April, 1956, about 656,000 pounds of shrimp were landed in Havana from Dry Tortugas (Table 1).

About 10 per cent of the total shrimp catch at Dry Tortugas was frozen and exported to the United States. The remaining 90 per cent were sold as fresh shrimp, heads on, at local markets in Havana.

The average prices paid to fishermen at Havana were: 40 cents per pound, heads off, jumbo size; 30 cents per pound, heads off, medium and small sizes; and 25 cents per pound, heads on, any size.

TABLE 1

Landings at Havana of Shrimp caught at Dry Tortugas from May, 1955 to April, 1956.

Month	*No. vessels*	*No. trips*	*No. fishermen*	*Landings in Pounds (heads on)*	*Catch per trip in lbs.*
May	11	12	51	39,928	3,325
June	13	14	54	39,493	2,820
July	12	15	56	49,407	3,280
August	13	18	60	57,105	3,190
September	14	17	63	57,570	3,386
October	12	13	56	51,419	3,955
November	11	15	53	52,376	3,491
December	12	16	56	59,254	3,703
January	14	18	64	66,164	3,453
February	15	23	75	94,321	4,100
March	14	16	72	67,254	4,203
April	06	06	27	21,504	3,584

Spiny Lobster Fishery

The spiny lobster fishery is the most important of the Cuban shellfish industries. Even though this industry has improved remarkably, especially during the last five years, its methods are still primitive. Almost all Cuban spiny lobster fishermen use a small circular net tied to a metal hoop at the end of a long pole (a bully net or *chapingorro*). They employ this gear from small row boats which they carry on larger sailing vessels to the fishing grounds. A wooden bucket with glass bottom and a long pole with an iron point at one end (*pincharra*) are aids to fishing operations. Only a few Cuban fishermen use large circular bamboo traps (three feet long and two feet diameter) to catch spiny lobsters.

In Cuba, there are about ten freezing plants for processing spiny lobster tails; the largest are located at Pinar del Rio and Havana. They pay fishermen $12.00 or $13.00 for each box of 60 pounds of spiny lobster, heads on (about 20 to 21½ cents per pound).

Table 2 shows that there has been a noticeable decrease in the export of canned and boiled spiny lobster, while fresh and frozen spiny lobster exports have increased (Table 3).

TABLE 2

EXPORTS OF CANNED AND BOILED SPINY LOBSTER, 1946-1955

Year	*Weight in Kg.*	*Value in Dollars*
1946	344,170	719,642
1947	426,724	763,775
1948	195,376	311,723
1949	79,213	150,052
1950	133,836	263,668
1951	26,616	54,253
1952	27,549	45,016
1953	50,629	101,195
1954	28,266	54,137
1955	72,071	67,027

TABLE 3

EXPORTS OF FRESH OR FROZEN SPINY LOBSTERS, 1946-1955

Year	*Weight in Kg.*	*Value in Dollars*
1946	72,795	67,813
1947	166,626	167,615
1948	506,205	564,836
1949	644,740	653,468
1950	676,668	629,988
1951	449,316	639,979
1952	806,985	865,029
1953	1,120,783	1,171,579
1954	1,390,509	1,498,612
1955	1,518,557	1,733,954

Shark Fishery

After World War II the shark fishing industry in Cuba decreased remarkably. A year ago (1955) only one shark fishing center existed. This was at Cojimar, a small port near Havana, where a small processing plant is still working. However, in the last year, new shark fishing centers have been opened up at Casilda, Tunas de Zaza and Santa Cruz del Sur on the south coast of Cuba and at Isabela de Sagua and Caibarien, on the north coast.

At Cojimar fishermen catch sharks using 20 fathom set lines made of henequen rope (¼ - ½ inch diameter). To the main line are attached, at different intervals, three branch lines from 10 to 40 fathoms in length, bearing one hook with 1½ to 3 inch openings. At other fishing centers chain set lines are employed, with seven to fifteen hooks. Sometimes heavy hemp rope is used for the main line and galvanized chain for the branch lines.

The average monthly catch in the main fishing ports is from 50 to 80 sharks per boat. At Cojimar fishermen are paid $2.00 per shark (any size), while at other fishing centers payment is according to the length of the fish, at the rate of half a cent per inch. The sharks most commonly caught commercially by Cuban fishermen are hammerhead *(Sphyrna diplana),* tiger *(Galeocerdo cuvier)*, man-eating (*Carcharodon carcharias*), six-gilled (*Hexanchus griseus),* black-nosed *(Carcharinus leucas),* and night shark *(Aprionodon isodon).*

The principal products of the shark industry are salted skins, fins and liver. During 1954, Cuba exported to the United States 14,290 Kg. (41,438 pounds) of shark skins, this figure having a value of $4,144.

Tuna Fishery

The tuna fishing industry is the largest in Cuba in terms of plants and other processive facilities. There are eight canneries, which work part of the year. There are two each at Batabano, Isla de Pinos and La Coloma, and one each at Cojimar and Pinar del Rio. The production of all these canneries together does not supply the tuna consumed in Cuba.

Tuna fishery started in 1940 on the southwest coast of Cuba, mainly at Batabano. Local fishermen of Japanese ancestry taught Cubans to catch tuna for commercial purposes using pole and line, and "manjua" *(Anchoviella epsetus* and *A. perfasciata*) or cabezona, (*Antherina perfasciata*) as live bait. It has been a successful fishing method, but sometimes fishermen say that even when they encounter large schools of tuna, the fish do not take the bait, and for this reason their catches are much smaller than they could be. Another problem in this fishery is the considerable waste of time spent looking for live bait (manjua). There is a high mortality rate of these fishes in the live well tanks of the tuna fishing vessels.

The blackfin tuna *(Thunnus atlanticus)* and the skipjack or oceanic bonito *(Katsuwonus pelamis)* together compromise more than 90 per cent of the commercial tuna catch of Cuba. Both species are called "bonito" locally and no distinction is made between them.

Tuna fish is mainly packed in peanut oil or oil and tomato sauce and they are labeled as "Bonito en Aceite" and "Bonito en Tomate" respectively. Table 4 gives the production during 1955 of three main canneries located at Batabano, Isla de Pinos and La Coloma. They employed eighteen tuna fishing vessels, using crews of six to eight men and an average of seven to ten days at sea fishing. These three plants produce almost 80 per cent of the Cuban production.

TABLE 4

PRODUCTION OF THREE TUNA CANNERIES, 1955

Month	LANDINGS IN POUNDS				CASES OF 24 CANS EACH			
	Batabano	*I. de Pinos*	*La Coloma*	*Total*	*Batabano*	*I. de Pinos*	*La Coloma*	*Total*
January	——	——	——	——	——	——	——	——
February	19,205	28,083	——	47,288	830	1,114	——	1,944
March	154,290	67,162	77,660	299,112	6,126	2,728	3,116	12,070
April	141,392	188,944	130,800	461,136	5,943	7,471	5,120	18,534
May	148,982	161,778	164,040	474,800	5,709	6,125	6,092	17,926
June	91,885	58,041	75,455	225,381	3,402	2,281	2,727	8,410
July	49,162	78,588	90,100	217,850	1,804	3,028	3,519	8,351
August	92,632	71,826	61,080	225,538	3,429	2,886	2,513	8,828
September	105,225	29,392	45,650	180,267	4,142	1,162	1,854	7,158
October	42,475	——	60,120	102,595	1,620	——	2,385	4,005
November	62,790	70,000	61,200	193,990	2,285	2,811	2,394	7,490
December	62,847	68,687	62,400	193,934	2,484	2,815	2,444	7,743
Total	970,885	822,501	828,505	2,621,891	37,874	32,421	32,164	102,459

Grouper and Snapper Fishery

The deep sea fishing for grouper and snapper, mainly at Campeche Bank, Mexico, is called by Cubans "pesca del alto." This is the fishery that lands a greater amount of fish than any other in Cuba. It was started many years ago by the Spanish fishermen who lived in Havana. Sometimes, during the summer, and especially in the hurricane season, the snapper-grouper fleet moves from Campeche to the west coast of Florida.

The fishermen use hand lines with three hooks each for catching grouper and snapper. A few years ago the introduction of hand reels was attempted but even though they gave very good results the whole fleet is still employing lines.

During 1955, there were 68 Cuban fishing vessels fishing in deep water for grouper, snapper, kingfish, etc.

Fifty-three vessels of this fishing fleet carry ice for fish preservation and fifteen use live-well tanks. Six vessels of the fleet are sail-propelled, the rest are both motor-driven and sail. The average crew is ten or eleven men and they spend around 20 to 23 days at sea. They take about four days for the round trip to the fishing grounds leaving 16 to 19 days of effective fishing, working from about 6 a.m. to 6 p.m. each day.

Table 5 shows the extent of fishing operations and the landings at Havana during 1955, of 47 vessels which belong to a fishing cooperative in this port. In that year they caught 3,620,423 pounds of grouper and 267,154 pounds of other kinds of fish. Thus the grouper catch is more than 90 per cent of the total catch. Almost all the fish is sold at Havana markets as fresh fish.

Another fishing cooperative named "Felipe Poey" was established at Havana. It is a branch of the BANFAIC (Bank of Agriculture and Industrial Development of Cuba), but there is no information available about its recent activities. A few years ago this cooperative tried freezing grouper fillets and shrimp, but later they closed the freezing plant.

Imports and Exports of Fishing Products

There is a large disproportion between Cuban imports and exports of fishing products. While during the last ten years (1946-1955) Cuba has imported $73,083,518 worth of fishing products such as cod, sardine, herring, mackerel, salmon, tuna, oyster, squid, etc., exports reached only $16,171,709.

Cuba reached import peaks in 1952, with a value of $9,043,771 and in 1951, with a weight of 21,065,000 Kg. The two main imported fishery products are cod and sardine. In 1955, Cuba imported 12,705,002 Kg. of cod with a value of $4,968,468; that same year sardines reached 3,209,312 Kg. with a value of $1,345,703.

The export peak was reached in 1955 with 2,387,373 Kg. and a value of $2,546,177. The most important Cuban export among fishery products is spiny lobster tails, fresh or frozen. The best year during the last ten was 1955, in which the country exported 1,518,557 Kg. of spiny lobster tails with a value of $1,733,954 (Table 3).

TABLE 5

FISHING OPERATIONS AND LANDINGS AT HAVANA OF 47 DEEP WATER FISHING VESSELS DURING 1955

Month	*No. of Vessels*	*No. of Trips*	*No. of fishermen fishing*	*Grouper Pounds*	*Snapper and Kingfish Pounds*	*Total production in Pounds*	*Total Catch per trip in Pounds*
January	20	20	201	232,652	23,288	255,940	12,797
February	26	26	270	309,898	25,456	335,354	12,898
March	27	28	279	327,072	22,933	350,005	12,500
April	24	27	247	247,873	19,707	267,580	9,910
May	32	32	323	296,677	47,813	344,490	10,765
June	33	36	337	253,384	42,764	296,148	8,226
July	33	34	335	308,202	28,242	336,444	9,895
August	26	26	262	268,706	7,526	276,232	10,624
September	25	26	253	318,037	4,507	322,544	12,405
October	26	27	265	384,611	33	384,644	14,246
November	23	24	229	335,978	1,370	337,348	14,056
December	25	25	261	337,333	43,715	381,048	15,241
Total				3,620,423	267,354	3,887,777	

The National Institute Of Fisheries Of Cuba

THE PRESENT Cuban government, aware of the deficiencies which have existed in all branches of the fishing industry during the past, and aiming to incorporate that valuable part of the public wealth into the general economic development plans now underway, created the National Institute of Fisheries on January 11, 1955.

The Institute is invested with the power to participate in all matters related to the fisheries, both the conservation and utilization of the aquatic products, and the adoption of measures intended to raise the standard of living of the fishermen. The Institute is governed by a Directive Council and an Executive Committee. In these are represented all sections of the fisheries, that is vessels owners, industrialists, retailers, commission agents and fishermen, as well as delegates from the governmental departments related to the fisheries.

In addition, the Institute provides information and answers questions, scientific and practical, on any matter related to the fisheries. It prepares and publishes literature in regard to the utilization of fishery products and distributes such material to the industry. It also compiles and publishes statistics on production, imports and exports, public and industrial consumption, fishermen, boats and gear, and other subjects related to fishing and the fishery trade in Cuba. Licenses for fishermen, boats, nets and other equipment, and for wholesale and retail establishments are issued by the Institute.

This agency also inspects the industry for compliance with the laws and rules regulating the capture of fish and other aquatic life, and its sale and manufacture. Enforcement of the sanitary laws are in charge of the Cuban Public Health Department in cooperation with the Institute.

In its first year of activity the Institute has devoted its major attention to the study of such measures as may contribute most effectively to the development of the fishing industry and to the welfare of the fishermen. The Institute has made a determinated effort to assist all interests connected with the industry.

With the aim of reducing the operating costs of fishermen, the Institute has put into service two freezing plants located at important fishing ports, and is formulating plans to install others. Soon, with some financial aid from the Bank of Economic and Social Development, an organization of the Cuban government, the construction of the first fishery landing facilities at Havana will be started. It is not necessary to list all benefits that will come from this, but the Havana Fishery Terminal will constitute a major improvement in the mode of operation of the Havana fisheries.

With the further cooperation of the Development Bank, the Institute in a short time will have refrigerated freight cars and trucks that will allow the shipment of fish and shellfish to all parts of the country. The Institute will provide for the installation of display refrigerators in all commercial establishments that sell fish and other marine food products, thus insuring its maintenance in optimum condition up till time of sale.

The Institute has already attained one of its more important objectives, that is to produce confidence among management and workers in the stability and future of the industry. This policy of the Institute contributed significantly to the formation of the "Cuban Cod Company" that soon will start the construction of its first plant in the port of Mariel. Other Cuban and foreign

concerns have announced their intention of investing capital in Cuba in the development of the fisheries.

The Institute is taking the necessary steps to establish an aquarium, a museum and a library. It is conducting studies of technology and of methods of repopulation of the rivers and other fresh waters. It is planning the construction of freezing plants, the formation of fishermen and boat owners' cooperatives and the establishment of schools where fishermen's sons will be taught methods of fishing.

It should be emphasized that Cuba, by virtue of its geographical position, is ideally located for fishing activities and for production of marine products, not only for its own use, but also for export to other countries. In the fisheries and in other marine enterprises investors may find in Cuba excellent opportunities. The National Institute of Fisheries will gladly furnish information to all persons—industrialists, administrators or scientists—who make requests about prospects and conditions in Cuba.

Marine Fisheries of the Yucatan Peninsula, Mexico

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THIS PAPER is a progress report on the investigations of the fisheries of the Yucatán Peninsula, México, carried on by the author from 1954 to the present, under the auspices of the Mexican Institute of Natural Renewable Resources and the Fisheries Department of México.

The zone of study, called "the Southeast," includes the States of Campeche and Yucatán, and the Territory of Quintana Roo. The two states are located on the Gulf of México, while Quintana Roo faces the Caribbean, with British Honduras on the South.

The Peninsula has an area of about 138,000 square kilometers (54,000 square miles), and a very low index of population. The main cities, and therefore the main markets within the Peninsula, are Mérida, Campeche, Chetumal, Progreso, Ciudad del Carmen, and Valladolid. There is no exact information on the total local consumption of fishery products, but it is known that the figure is small. This is due to the low density of population rather than a lack of appreciation for sea food, as the "Yucatecos" have been great fish consumers since the times of the Mayan Empire.

Local transportation facilities are very limited. The only important highway goes from Puerto Juarez on the Caribbean (a port planned for construction in front of Isla Mujeres) to Campeche and the small town of Champotón, passing through Mérida. From the main highway, several minor roads take off to smaller towns. In Quintana Roo, transportation is done by mule, "plataforma"—a railroad car without cover, moved by animal traction—boat, or plane. The only land communication between the Peninsula and the rest of the country is the railroad, but most fresh or frozen fishery products are distributed by air. There is an important road under construction that will link Yucatán to the rest of México, but as it has to cross very rough and swampy country, it will not be ready until 1959 or 1960.

Campeche Sound includes the continental shelf from about Términos

Lagune to Isla Cancún. Its maximum width is found in front of Yalkubú Point where it extends for more than 250 km. and becomes narrower towards the State of Tabasco. Two different types of bottoms are found in the Sound, a calcareous bottom densely sprinkled with coral patches and banks, that extends from about Champotón to the Yucatán Channel, and a sedimentary type south of Champotón, composed of mud and sand, where most Mexican shrimp trawlers operate.

Production comes from the Campeche Sound almost entirely. The main fishing areas are: 1) some coastal and estuarine waters of Campeche and Yucatán; 2) the area of the keys and islands of the Sound; and 3) the Yucatán Channel.

Fishing equipment ranges from the hand line, responsible for the bulk of the fin-fish catch, to the modern otter trawl. There is very little mechanization, except in the shrimp fishery, and even in snapper fishing at great depths, lines are operated by hand. Drift gill nets are widely used for small sharks, rays, pompano, and many other coastal and estuarine fishes. Beach seines are responsible for a small part of the catch, and cast nets, although very popular, serve mostly for the capture of bait. Long lines and trot lines are seldom if at all used. In northern Quintana Roo and Alacranes Reef, traps and bully nets are employed in the capture of spiny lobster.

Fin fishing is carried on from small sail boats of less than five tons, operating in protected waters or close to shore. In the capture of sharks off the northern coast of Yucatán the same craft, with no other navigational aid than the compass, and with the fishermen depending on their own intuition as indication of possible weather changes, go out for more than 40 km (25 miles) in search of the catch. In the grouper and snapper fisheries, the fleet is somewhat larger, ranging in size from five to twenty tons.

By far the main fishery of Yucatán is for shrimp. Of secondary importance are groupers, snappers, sea turtles, mojarras, snook, sardine, and many other estuarine and littoral species.

The Mexican shrimp fishery of the Gulf of México has had a very rapid development. For ten years after the discovery of commercial concentrations of the crustacean by the Japanese exploratory fishing vessel *Sapporo Maru* in 1936, there were no shrimping activities, but in late 1946 some American boats based in ports of the United States, began trawling for shrimp in the Campeche Sound with the authorization of the Mexican Government. Since the trip across the Gulf was expensive and time consuming, some companies settled at Ciudad del Carmen and established freezing plants, some still in operation. The industry began to grow rapidly and due to the high prices national as well as foreign capital was invested in new shrimp trawlers and plants. By 1954, only eight years after the first boats began operations, more than 200 Mexican trawlers were fishing the Campeche Banks and a larger number of American craft were exploiting the same grounds.

Mexican shrimp trawlers are modern boats ranging from 20 to 90 tons. Many were purchased in the United States, but most of them were built in Ciudad del Carmen or Campeche. They operate in less than 25 fathoms of water from about Champotón to Tabasco and it is very uncommon to find them as far away as any of the keys of the Sound or north of the port of Campeche.

The catch is handled by 11 freezing plants, 10 established at Ciudad del Carmen and one at Campeche. Almost all the production is exported to the United States.

The same species of shrimp caught along the Gulf coast of the United States are fished in México; the pink shrimp (*Penaeus duorarum*) is found from south of Campeche to Cape Catoche, but only some restricted areas have suitable trawling bottoms; white shrimp (*P. setiferus*) goes from about Celestún, Yucatán, south, from shore to the 20 fathoms contour and the brown shrimp (*P. aztecus*) follows approximately the same distribution as the last one, but in deeper waters. As is to be expected, this distribution is not as sharply cut as mentioned, often overlapping on its neighboring lines, and it is not infrequent to find individuals of one species far from their usual zone of distribution.

There is no fishing for shrimp in estuarine or inland waters, except for a dwarf species (*Palaemon* sp.), caught in large numbers in the neighborhood of the port of Campeche. This tiny decapod of not more than two inches in size, the largest individuals, are headed, peeled, and served as shrimp cocktails in restaurants, often taking close to a hundred of them to fill up a glass.

Second in importance is the grouper fishery that operates in all the banks close to shore from about Celustún to Isla Mujeres. The main species taken is the common red grouper (*Epinephelus morio*), but other serranids, as the spotted jewfish (*Promicrops itaiara*), the nassau grouper (*Epinephelus striatus*) and several species of snappers are included in the catch. The fishing fleet is composed mainly of sail boats of three to 15 tons, with some smaller than three and a few larger than 15. Fishing is done by hand lines, without the help of mechanical devices, in waters up to 50 fathoms depths. The bulk of the catch is frozen or salt dried, with only a small part being sold fresh. There is a freezing plant at Progreso that sends the product by air to México City or by boat to Puerto Rico. This resource, although rather heavily exploited, could withstand more intensity of fishing, but larger craft with auxiliary motors and mechanized fishing equipment are needed in order to reach new or underdeveloped grounds.

Turtle fisheries are carried on all along the coast from Campeche to British Honduras and, to a certain extent, in the islands of the Campeche Sound, but it is only organized in the Yucatán Channel area, from south of Isla Mujeres to Cape Catoche. The three main commercial species of marine turtles, the hawksbill (*Eretmochelys imbricata*), loggerhead (*Caretta caretta*) and green turtle (*Chelonia mydas*) are present in large quantities, but only the last one is subject to exploitation in large scale. Loggerhead supplies a restricted local market; the hawksbill, of some importance in the past for its precious shell, is seldom captured now.

Fishing with nets is responsible for the bulk of the catch. Harpoons, or the primitive method of turning the turtle on its back as they come to shore to lay during the breeding season, are also methods employed for catching turtles. All the catch from the Yucatán Channel area is taken to Isla Mujeres where the turtles are kept alive in weirs until a boat comes and carries all the green turtles to Tampa, Florida, the main market for the product.

It is felt that the present production could be increased by extending the fishery to more southern waters of Quintana Roo and by including the loggerhead in the catch, a species for which a national market could be developed with appropriate advertising and sales promoting campaigns.

Prior to 1939 there was an important population of sponges inhabiting the waters of Quintana Roo, which was harvested with some intensity, but the same disease that depleted the beds of British Honduras, Cuba, Florida, and the Bahamas in 1938-39, cleared off the stock to such an extent that the population, although now lightly fished, and this only in the north, has never recovered.

The rest of the fisheries production of Yucatán is made up of littoral and estuarine species like small sharks, mojarras, snook, croakers, pompanos, sardines, barracudas, etc. Bottom dwelling forms such as spiny lobsters and sea snails (*Strombus* spp.) are plentiful off Quintana Roo, but are captured only in limited numbers for local consumption. Shark fishing was an important

industry in the past, but is now reduced to a few areas where operations are carried out on a small scale.

The poor state of development of the fisheries of the Yucatán Peninsula shows a remarkable contrast to the vast resources of its waters. The causes for this situation should be looked for in economic rather than biological conditions. Among the most important ones are lack of financial assistance for anything outside the shrimp fishery, transportation difficulties within the Peninsula and with the rest of the country, inadequate cold preservation and cold storage facilities, and insufficient markets for the production.

In regard to the potential fishery resources, the abundance of spiny lobsters and sea snails in the Caribbean has already been pointed out. Lobster fisheries may be increased considerably, as only a small part of the fishing area is being exploited, while sea snails of the genus *Strombus* and *Melongena* could easily sustain a canning industry similar to the abalone industry of Baja, California.

A survey of the bottoms suitable for sponge culture is needed, as there are indications that sponge farming could be an important development in the Yucatán Peninsula. The author has estimated the existence of about 300 square kilometers (117 square miles) of such bottoms in the Mexican Caribbean, which means that other ecological conditions being appropriate, they could produce over 600,000 kg of cultivated sponges annually. The figure may seem high but it may be well below the actual number if we consider the results obtained by Moore (1910) in Florida, Smith (1948) in the Bahamas, or the Japanese at the Ailinglapalap Atoll (Cahn, 1948).

Small sharks are captured in tremendous quantities in shallow waters and perhaps an increase in production should not be recommended, but on the other hand, fishing for large sharks offers great possibilities as a consistent source of animal protein in the form of dried meat that could easily reach poorly communicated towns without cold storage facilities. The low price that makes shark meat of importance, can be sustained by the profit obtained from the livers and hides. For those not familiar with the product it must be said that when properly processed it makes a fine substitute for dried cod.

In the Caribbean the most important resources are the pelagic species, such as the sharks, fish of the mackerel family, sardines, barracudas, probably the tunas, sea turtles, and others. Demersal groups are abundant, but the volume is dispersed in several species, an important inconvenience from the marketing point of view, for its proper utilization.

On the Gulf of México, however, fishing for estuarine and some continental pelagic species such as squids, sharks, jacks, sardines, and mackerels, could account for an important increase in production. It is suspected that commercial quantities of menhaden may occur in the waters of the state of Campeche, and the survey of the United States exploratory fishing vessel *Oregon* has given evidences of exploitable concentrations of bluefin tuna in deep waters off the continental shelf. Perhaps the main potential resource of the Gulf of México for Yucatán lies in the demersal fin fisheries, at present almost entirely in the hands of foreign fishermen.

All the necessary conditions for the development of the marine fisheries of Yucatán being at hand, a prosperous future for this important industry can be forecast.

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Developing A Caribbean Fishery

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THE ISLANDS OF THE WEST INDIES are mostly divided by vast stretches of water, often with 100 miles or more between islands. As a consequence, the islands have been isolated in their approach to fishery development. This paper is not directed to any particular scientific approach to the problem that confronts fishery development for the West Indies, but is a suggestion for the persons administering fishery matters for the area.

In August, 1956, the islands of the British West Indies agreed to become a Federated British West Indies. With some general agreement now possible between the British islands, it is felt that a quicker approach to fishery development may now be possible. It is hoped that West Indian islands of other nations might be encouraged to join with the new union in a general approach to fishery matters, and it is suggested that the time has arrived when it should be possible to zone the islands of the Caribbean into areas of fishery research. Each zone would then approach their research problems on some organized plan which would have some relation to the research work being undertaken in the neighboring zones.

To carry out the necessary research each zone would be required to establish a number of research boats, equipped to develop and explore new types of gear and techniques, always bearing in mind that the fishermen and boat-owners of the Caribbean are usually persons of limited means. Elaborate ships are not required, but rather a number of good 30-40 foot sea-worthy diesel powered boats, fitted with two engines to create confidence and with the necessary instruments for communication and navigation, and manned by capable West Indian seamen.

Research, as is being suggested in this development program, is of a long term nature, and the islands should be prepared to join in these experiments for a term of at least ten years.

Fishery development affects so many aspects of fishery matters that the entire structure on the respective islands must come in for adjustments, so as to fall in line with advances that might be brought about as a result of improved fishery techniques and gear. This may mean a complete change to a better type of boat, which from observations, is the first major problem for almost all of the islands of the Caribbean. A better market price for fish, as against the price of other proteins, may also encourage new blood to enter the fisheries. Research into methods of distribution and storage is required, where large catches may justify such activities.

The suggestion of zoning the islands is not only for matters of research,

but is really a collective approach to the general uplifting of the fisheries of an area. The following zones are suggested as being logical:

(I) Working from the southern area of the Caribbean, the islands of Trinidad and Tobago are big enough to form a zone. The fisheries of Trinidad are of a somewhat different nature than the islands to the north.

(II) The next zone could be Grenada, the Grenadines, St. Vincent, Barbados and St. Lucia. This second group starts in what might be termed the clear waters of the Caribbean and many important fisheries could be developed, if the administrative problems were first settled.

(III) The third zone could be Martinique, Dominica and Guadeloupe, if some agreement could be worked out with the French authorities; otherwise, Dominica, Montserrat, Antiqua, St. Kitts and the dependent islands would form group IV.

(IV) It is hoped that the British and United States Virgin Islands would work together.

(V - VII) Puerto Rico, the Dominican Republic and Haiti are all large enough to be considered three separate zones.

(VIII - X) Jamaica and the Cayman Islands would be another zone; Cuba yet another, and the Bahamas the last zone.

Many of the larger islands, such as Cuba, Jamaica and Puerto Rico have realized the importance of fishery development and are organizing programs to suit their individual needs. The size and financial positions of many of the smaller islands southeast of these, do not allow them to tackle fishery development singly. Hence it is my opinion that these smaller islands should come together under respective zones and group themselves together financially to undertake what could become very extensive fisheries. The islands could then engage the services of fishery workers, whose business it would be to arrange and plan research programs and pass them over to be implemented by the Fishery Officer of the zone. The Fishery Advisor himself should visit the islands of the zone from time to time, with a view of making recommendations to the governments of the various islands as to matters that may require improvement. Such officers would be the key men connected with matters of administration and be the liaison between governments of the area in these plans for fishery development.

Many years ago it was felt that the waters around Barbados contained little or no fish, but after only six years of fishery research the production of the fishing industry has been quadrupled.

Fish similar to those taken off Barbados are caught in commercial quantities as far north as Dominica, and south and northwest off Grenada, St. Vincent and St. Lucia.

For example, such species as the flying fish *(Hirundichthys affinis),* and the dolphin *(Coryphaena hippurus),* which make considerable contribution to the Barbados fisheries, have been taken by boats over two hundred miles southeast of Barbados. Yellowfin tuna can be found from Barbados to Grenada and on to Dominica, where they appear in considerable numbers in the Martinique channel. The same fish are often seen off Florida and in the Gulf of Mexico.

In all of the British West Indian islands, fisheries have been entirely left to the native fisherman, whose financial resources are in most cases very limited—so much so, that some three hundred years after colonization, we find fishermen of some of these islands going to sea in the type of canoe their forefathers used, and applying ancient fishing techniques. While it may be admitted

that some of the old fishing techniques may be useful, a gradual adoption of modern methods would increase catches.

To a large extent the developments of modern fishing methods are restricted to the particular type of craft used in the area, so it would appear that the first major problem is a gradual conversion to a better type of fishing boat. The entire Caribbean area appears to require modernization of their fishing boats before fishery workers can expect to accomplish much.

Some surveys have been carried out of most of the Caribbean fisheries, and although reports present a generally pessimistic outlook in many cases, this is because of the limitations of the boats and gear available in most cases.

Fishery workers in the Caribbean must be prepared to develop boats and techniques which can be used to catch pelagic species, since only in limited areas can trawling be carried out. Besides, in clear water fish cannot usually be taken in commercial quantities by trawling.

The number of schooling pelagic species seen in the Caribbean often runs into many millions of fish. Especially plentiful are the bonito family, of which at least three species are known. Next is the dolphin, followed by the yellow-fin tuna, which are taken from Barbados to Grenada to beyond Dominica. Wahoo are also caught on isolated fishing banks. Added to these is the flying fish, for which Barbados is fast becoming a tourist attraction, and which also provides food for many of the other fish listed. The flying fish catch in Barbados is the most important phase of the fishery of this island. Over 6,000,000 lbs. of flying fish were marketed in Barbados over each of the last three years. There is no reason why these fish should not be taken in large commercial quantities in many of the islands, since they are off their shores in considerable numbers.

After noting the rate of population growth in the West Indies, it would be reasonable to expect that most of these islands could consume more fresh or frozen fish caught locally. This could replace the large quantities of salted fish which are imported annually.

Governments were forced during the last world war, and in some cases up to the present time, to subsidize salted fish. Even with a subsidy, the selling price of salted fish exceeds that of some of our prime fish species, (prices of which are still controlled in some islands), by as much as 8-10 cents per pound. Surely this is a situation that requires study. A fisherman sometimes must buy salted fish at prices higher than he receives for his prime fresh product.

With the high price of salted fish, fresh fish is in great demand and should be encouraged to remain so; but the demand in a number of islands exceeds the supply. Governments would be well advised to consider allocating sums comparable to the annual subsidy on salted fish, to develop their fishing industries. These, in many instances, are depressed and in need of considerable financial help and guidance. Governments should realize the high protein value of fresh fish to their peoples and should assist this important food industry, in order that their countries might become self-supporting in fishery products. Otherwise, in a short time from now, islands will be forced to import fresh frozen fish at prices beyond the means of the ordinary people of the islands.

With proper organizing, the fisheries of the West Indies could easily be worth millions of dollars more than at present. These same fisheries could also

employ many more persons than at present and feed thousands more people.

To carry out the re-organization of West Indian fisheries first requires on-the-spot expert advice, fishery administration, legislation, better boats and gear.

With determined programs of fishery development, calculated to bring a better type of living to the active fisherman, the islands would advance in fishery production beyond their fondest dreams. The fish species of the Caribbean only have to be seen to be believed, and man's job should be to devise ways and means to produce such species as food. This cannot be done without the tools. To quote Sir Winston Churchill—"Give us the tools, we'll do the job."

The Survey of Living Aquatic Resources

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The detection, appraisal and measurement of living aquatic resources is a sequence of development and refinement of information in which all sections of the industry and Government have deep interest. Unfortunately it is a process which is sometimes allowed to stop before completion; it is also one which some people believe can be telescoped. For those to whom fishing is little, if anything, more than hunting, it may seem sufficient if a resource is discovered, for them the scientist's work ends with the discovery. However, it is generally recognized that some estimate of the magnitude of the resource is desirable, and that the scientist is best equipped to make this. Nevertheless, whatever the prevalence of such views in some sectors of the "fishery" community, the main trend of thought on fishing theory is that effective conduct of fishing operations, let alone practice of fish-culture, requires detailed analysis of the resource, identification of its components and of the relations between these components, *per se,* and between the resource and its environment, and measurement of the influences exercised through these relations. In consequence, a theory of resources is evolving for the description of resources, *in situ,* for measurement of their response to simple exploitation and for identification of the opportunities they offer for postive intervention.

FAO has been informing regional fisheries councils and commissions of its work and plans in connection with resources survey, the term "survey" being employed to signify the whole range of theory and practice indicated above. The purpose of the present note is to give a detailed account of these plans which, naturally, have been developed in the last two years, and to report the progress that has been achieved in this work.

The FAO survey is, in a manner of speaking, a survey of surveys. It is an examination of information already accumulated concerning resources, of what is being done at present to increase and improve upon that information, and of the uses being made of the information. FAO does not carry out field or laboratory survey work, except in its Technical Assistance Programme, and even here its role is chiefly advisory and pedagogic. Some people have thought that FAO would commission sea-going vessels, carry out survey work and measure resources of particular areas. This thought derives from a misconception of the functions enunciated in Article I of the Constitution of the Organization.

FAO's first function is to collect, analyze, interpret and disseminate information. Its second function is a many-headed one relating to resources, primary production, marketing and distribution of food and agricultural products, agricultural credits, and agricultural commodity arrangements the Organization must promote and, where appropriate, recommend national and international action with respect to these matters. The Organization's third function is to furnish such technical assistance as may be requested, to organize missions, to assist member governments to fulfill obligations arising from their acceptance of the recommendations of FAO, and generally to take action necessary and appropriate to implement the purposes of the Organization. Under these terms the Organization is to assist member governments in the formulation and conduct of national programmes, and to supplement those programmes by appropriate international action. The position was well stated by the Chairman of the first FAO Conference, Mr. Lester Pearson, as follows: "FAO will bring the findings of science to the workers in food and agriculture, forestry and fisheries everywhere; and it will bring the practical problems of these workers everywhere to the attention of the scientists. It will assemble, digest and interpret information to serve as a basis for the formulation of policy, national and international. It can suggest action, but only through the activities of governments themselves can the objectives be finally won." It is in this sense that the FAO work on aquatic resources has been conceived.

Purposes of the Survey Programme

The primary purpose of the survey programme is to provide a continuous operation for the compilation and appraisal of what is known about the living aquatic resources of the world. This operation must bring information together in systematic and useful ways in order to serve a number of subsidiary purposes.

Firstly, to yield that increment of knowledge which derives from a synoptic view of data, especially if that view should be in new dimensions.

Secondly, to reduce great masses of data to tractable, more easily understandable form, so that governments should be enabled to obtain a clearer and more useful understanding of their country's resources; since their policy towards these resources, and their programme with respect to the industry exploiting these resources, are based upon this understanding, the importance of this purpose is self-evident.

Thirdly, to provide accurate identification of the significant gaps in this knowledge so that further research may be planned with greater efficiency. By the term "gap in knowledge" we refer to simple deficiencies in the description of resources required by present techniques of exploitation; we also refer, although the term is scarcely suitable for the purpose, to the indications which might be given of lines of research which might lead to the invention of new ways of intervening in the resource. The latter possibility relates more particularly to the field of fish-farming, and to such particular matters as the breeding of new varieties.

The secondary purpose of the survey programme is to furnish a sound basis for the promotion of national field survey work. It is clear that recommendations, made by regional fishery councils and commissions, for work of this kind, will be most effectively formulated if based upon correct appreciation of existing information.

The third purpose of the survey programme is to secure the best use of resources information in planning and conducting the exploitation of these resources.

The fourth purpose is to secure the constant development and improvement of the methods of investigation of resources. The constant review of available resources information, against the requirements stated by those responsible for exploitation, must from time to time indicate points where available research techniques are inadequate and unable to secure the data required.

Methods

This programme calls for operations falling roughly into two phases. On the one hand there are the bibliographic and other operations carried out by the Biology Branch in its offices at Rome; on the other hand, there are the consultations which the Branch enters into with fishery workers, either at the meetings of regional councils and commissions, or at special meetings convened by FAO, alone or (as in the case of the meeting proposed for Lisbon)[1] in collaboration with other bodies.

The central element of the Branch operation is the creation and maintenance of a series of thesauri. A thesaurus is a house of treasure and, in the present use, signifies a store of information. The thesauri, as a set, are encyclopaedic in scope, providing accommodation for all kinds of information relating to resources. The operation of the thesauri calls for rigorous selection and reduction of data. It employs all kinds of cartographic and diagrammatic systems of synoptic presentation of data; it calls for constant appraisal and re-appraisal of synopses and conclusions, in the light of latest researches; and it provides a machinery to make these possible.

There are five thesauri.

The first, the Country and Regional Thesaurus, is an accumulation of information about the resources of each country and region, viewed from the point of view of current exploitation; it leads, on the evidence of what is yielded at present, to an estimate of the nature and magnitude of these resources. The thesaurus is sub-divided according to a decimal geographic classification, and within each sub-division information is stored on the species fished, methods of fishing, catches taken, and interpretation of technological and economic information relating to the nature and intensity of fishing. It will perhaps be recognized that this array of information corresponds to that which has usually been presented in the past as representing the account of the fishery resources of a country.

The second, the Species and Stocks Thesaurus,[2] is a system of accumulation of information concerning species already brought under exploitation, and therefore of economic significance. It may be expected to accommodate species of potential economic importance at some later date. The arrangement of this thesaurus is basically according to a decimal codification of taxonomic groups; within each compartment information is arranged for each species according to a schedule described in a recent paper (Roscoff)[3]. The point of view dominating work in this thesaurus is that the organism of economic importance is a machine for the conversion of materials into form useful for man and therefore information must be sought on the operation of the machine and on the availability of materials to it.

[1] Workshop on Population Dynamics and the Selectivity of Fishing Gear (Joint ICNAF/ICES/FAO Meeting) Lisbon, Portugal, 1957.

[2] See Appendix 2.

[3] A Note on Abundance and Distribution of Marine Organisms of Economic Importance. International Conference on the Comparative Biology of Marine Species studied in Different Districts of their Area of Distribution, IUBS/UNESCO, Roscoff, France. 1956.

The third, the Oceanic Thesaurus, treats of oceanic areas and regions ecologically as units, and properly speaking is dominated by the concept of the resource as ecosystem. Its task is to identify natural ecological units and to accumulate relevant meteorological, and oceanographic information from the resources point of view.

The fourth, the Inland Thesaurus, is a companion piece to the Oceanic Thesaurus, and deals with inland systems, chiefly as river basins, from the ecological point of view.

Both the third and fourth thesauri are concerned with questions of production and productivity, but not only with basic, phytoplanktonic production, but also with secondary and tertiary production, and with the dynamics of these processes.

The fifth, the Methods and Subjects Thesaurus,[2] is concerned with the methods of resources investigation and with the principal subjects occupying the attention of workers in this field, for example, basic production and population dynamics.

Material for these thesauri is drawn from many sources, but probably the greatest is the wide range of literature which is searched by the Branch; much information is drawn, however, from correspondence, manuscript reports, and similar sources. The thesauri are supported by the index of sources, a collection of notched cards carrying standard bibliographic citations and such annotations or abstracts as may be found necessary.

Each piece of relevant information is transferred in the form of a brief text, a tabulation, diagram or map, into the appropriate thesaurus; it is to be emphasized that this operation is subject to strict rules of relevance, recency and authority. It must also be emphasized that this system is still in process of evolution: the Branch is still engaged on what is virtually research in the development of these thesauri. As material accumulates, a review is to be made from time to time of the status of each compartment of each thesaurus and according to agreed plan of priority, or to demands made upon the system, the accumulation in each compartment will be further reduced into standard synoptic form.

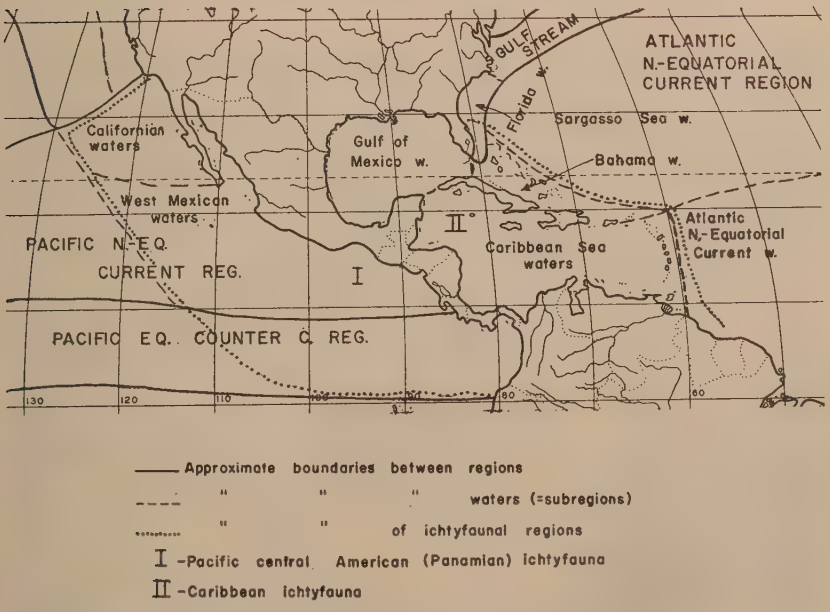
It will be recognized that there are close connections between the several thesauri and that generally three or more will be drawn upon for statements sought for special purposes. Thus, if a statement is requested with respect to the resources of a particular country, a beginning will be made with the material from the Country and Regional Thesaurus; this will indicate the species taken by the fishery of that country and a further reference will then be made to the Species and Stocks Thesaurus for information on each of these species, for information, for example, on maximum and average sizes to which the species grows in this and other waters. Again, reference will be made to the Oceanic and Inland Thesaurus for information on the ecology of the waters. On the other hand, if the starting point of the inquiry should be a species, the operation would commence with the Species and Stocks Thesaurus and then refer to the Country and Regional Thesaurus for information on current exploitation, wherever that might take place, and to the Oceanic or Inland Thesaurus for information on the habitat of the species.

The preceding description will have made clear that the work of the Biology Branch is essentially a derivative operation; it is one which is concerned with the treatment of data produced by programmes to which the Branch can make

little, if any, direct contribution, programmes which may have little relation with the general plan of the resources survey. This matters little so far as the first purpose of the survey is concerned, since, with respect to that purpose the survey must take all information, however haphazardly gathered, and test its relevance and value. Yet, it is these facts that make the second phase, of consultations with regional councils, of considerable importance. In this phase, the Branch prepares for each council or commission a synopsis of resources information relating to its area. Generally speaking, these synopses endeavor to make an appraisal of what is known of the resources of the area, and to offer a diagnosis of those resources, by a composition of three approaches. One: by examination of the evidence, chiefly from current exploitation, of the nature, composition and approximate magnitude of the resources of stocks of current economic importance. Two: by deeper analysis of the dynamics of these stocks for the purpose of determining the approximation of current exploitation to limits of yield from these stocks. Three: by way of examination of evidence on the basic productivity of the area and on the efficiency of the food chains through which this material passes to the economic species.

Preliminary papers have been prepared on the ICES, ICNAF and GFCM[4] areas and work is now proceeding for their revision and development. For the

Fig. I Natural regions in Central American (Caribbean American) waters



[4]ICES—International Council for the Exploration of the Sea.
ICNAF—International Commission for the Northwest Atlantic Fisheries.
GFCM—General Fisheries Council for the Mediterranean.

Gulf and Caribbean area only preliminary compilations have been made; these are represented here as a means of illustrating the lines along which the work is developing and the matters on which the Branch wishes to secure the advice and assistance of workers in this region.

The first of these figures presents a division of the Central American area, very broadly defined, into natural regions and sub-regions. The divisions, made on hydrological, ecological and ichthyofaunistic grounds, probably conform to accepted ideas; revision of these divisions in the light of more recent data and of newer interpretations, is essential to the development of this work, for it seems to us that the correct identification of ecological entities must be as important in this broad field of resource appraisal as it is in ecological work on smaller scale, and that it has a correspondence with the current identification of unit stocks (racial investigations) in fishery biology.

The second figure summarizes the information thus far reviewed on the nature of the coasts and continental shelves within the area. From the fisheries point of view a figure such as this has obvious relevance to such matters as (1) the extent of ground on which demersal stocks might be found; (2) the nature of these grounds insofar as this is a determinant of the fishing gear that may be used; (3) the nature of the coast insofar as this influences the in-shore fishing and affects the design of fishing craft; (4) the existence of brackish water areas that may be nursery grounds for shrimp and other fauna and which may offer opportunities for fish-culture.

Fig. 2 THE NATURE OF THE COAST AND CONTINENTAL SHELF OF THE CARIBBEAN AMERICAN WATERS

Fig. 3 OCEANOGRAPHIC CRUISES IN THE CARIBBEAN AMERICAN WATERS

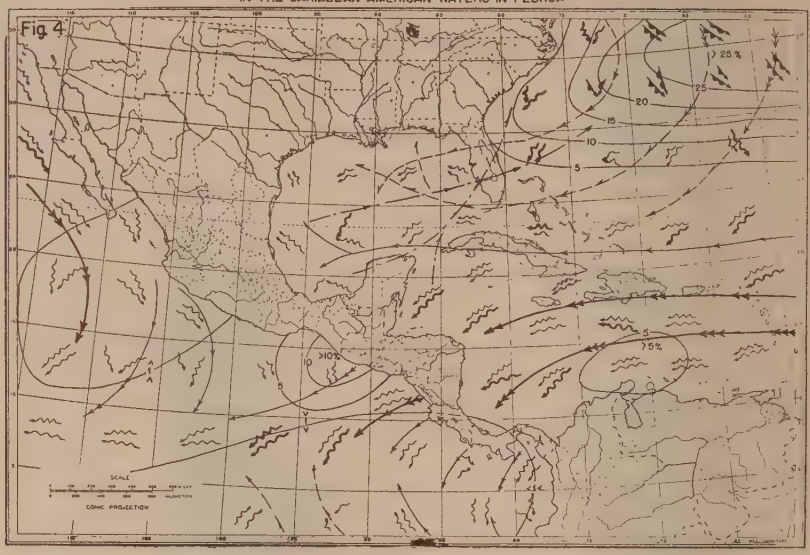
The next figure, which shows the tracks of some of the oceanographic and experimental fishing cruises that have crossed the area, represents that part of this work that is concerned with maintaining intelligence on the nature and scope of investigational work in each area.[5]

The main features of the meteorological regime of the area are summarized in the next two figures, and the surface currents and temperatures are summarized in the two figures which follow. Figure 8 shows the computed thickness of the wind-produced homogeneous layer and by implication refers to depth at which the thermocline is located. The figures of the final set exemplify the distribution in depth of important other features of these waters. Figures 4 to 14, quite apart from the inaccuracies they may contain, are, of course, a most inadequate summary of the characteristics of the area; they will, however, serve to illustrate two points relevant to the theme of this paper. Firstly it is intended in presenting these diagrams to emphasize the view that the full understanding of living aquatic resources can be achieved only by a thoroughly ecological approach. The second point, which is perhaps only an aspect of the first, is that as yet it is generally impossible to approach diagrams such as Figures 4 to 14 with the same confidence as we can Figure 2: in looking at Figure 2 we can make a number of useful, albeit simple, interpretations of the features it presents with respect to fisheries. We now need to be able to identify features, similar in significance, in hydrological and other diagrams.

[5]See Appendix 1.

SEA AND SWELL, WINDS, FREQUENCY OF MODERATE GALES AND HIGHER WINDS AND THE TRACKS OF TROPICAL HURRICANES IN THE CARIBBEAN AMERICAN WATERS IN FEBRUARY

Fig. 4



Sea and Swell

CONSTANCY OF DIRECTION

SEA
< 25 %
SWELL
25–50 %
> 50 %

DISTURBANCE: Sea; Swell
S and higher in % of all observations.
Swell: % of high swell.

Few or none
< 10 %
10–25 %
> 25 %

CONSTANCY OF DIRECTION

< 25 %
25–50 %
> 50 %

Winds

RESULTANT winds
in Beaufort scale

< 1
1–2
2–3
> 3

% of moderate gales (Beaufort force 7) and higher winds shown with isolines.

Tracks of severe cyclonic storms
(Tropical hurricanes)

FREQUENCY
Rare
Moderate

SEA AND SWELL, WINDS, FREQUENCY OF MODERATE GALES AND HIGHER WINDS AND THE TRACKS OF TROPICAL HURRICANES IN THE CARIBBEAN AMERICAN WATERS IN AUGUST

Fig. 5

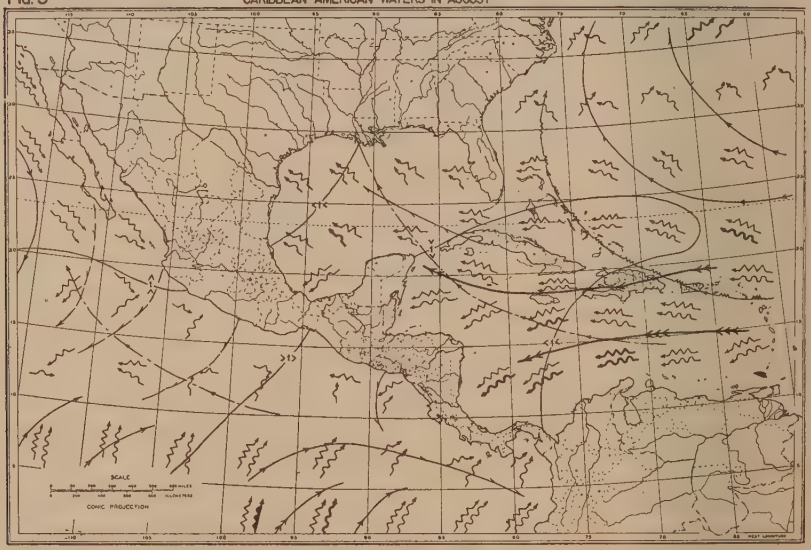


Fig. 6 SURFACE CURRENTS AND TEMPERATURES IN THE CARIBBEAN AMERICAN WATERS IN FEBRUARY

Surface currents

Frequency of direction		Average speed	
	< 25 %	Miles per 24 hours	Knots
	25–40 %	0–6	0–0.25
	41–60 %	6–12	0.25–0.5
	61–80 %	12–24	0.5–1
	> 81 %	24–36	1–1.5
		> 36	> 1.5

Divergence of currents.
Uncertainty determined divergence or other current boundary.
Convergence of currents
Upwelling of deep water.
Approximate centre of gyral

Fig. 7 SURFACE CURRENTS AND TEMPERATURES IN THE CARIBBEAN AMERICAN WATERS IN AUGUST

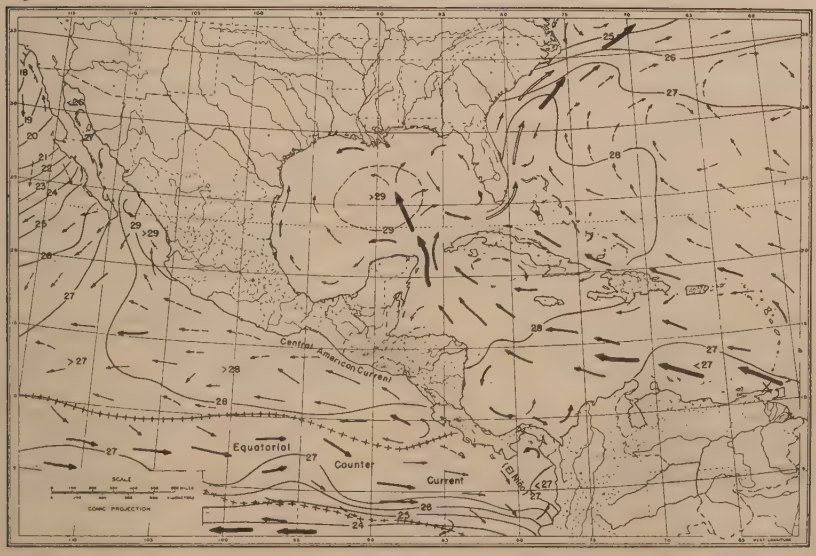
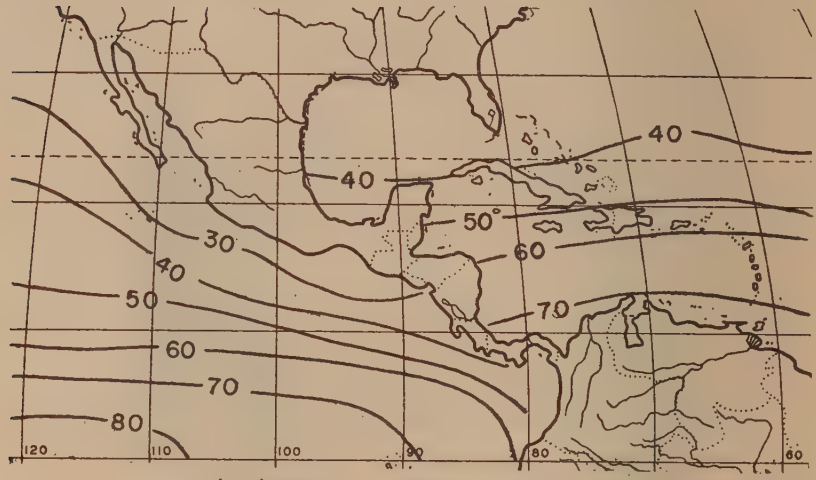
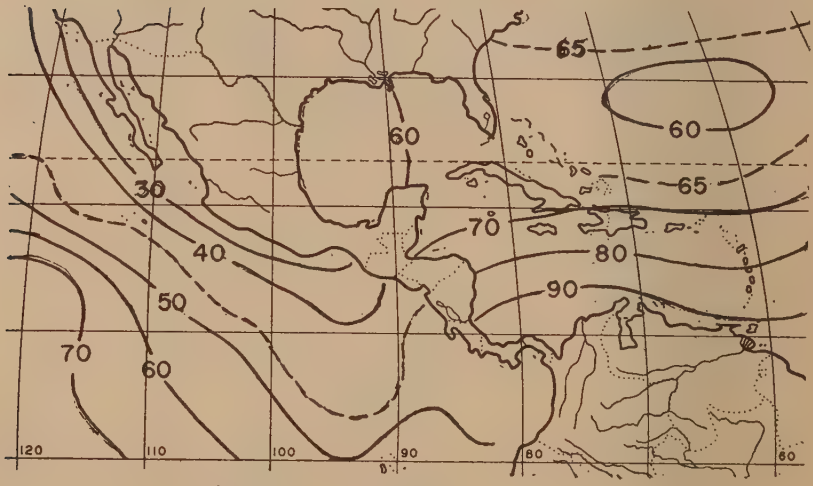


Fig. 8 Thickness (m) of the wind-produced homogeneous layer (after Lumby)



In January — March



In July — September

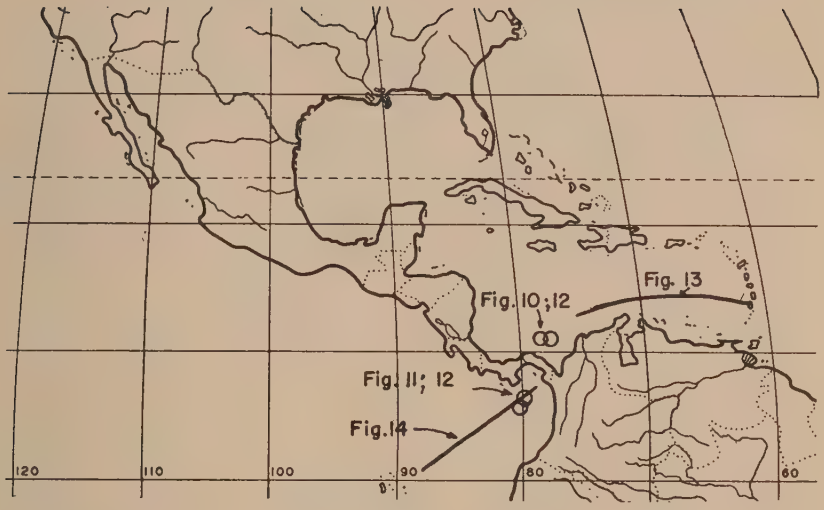


Fig. 9

Location of stations and sections presented on figures 10-14

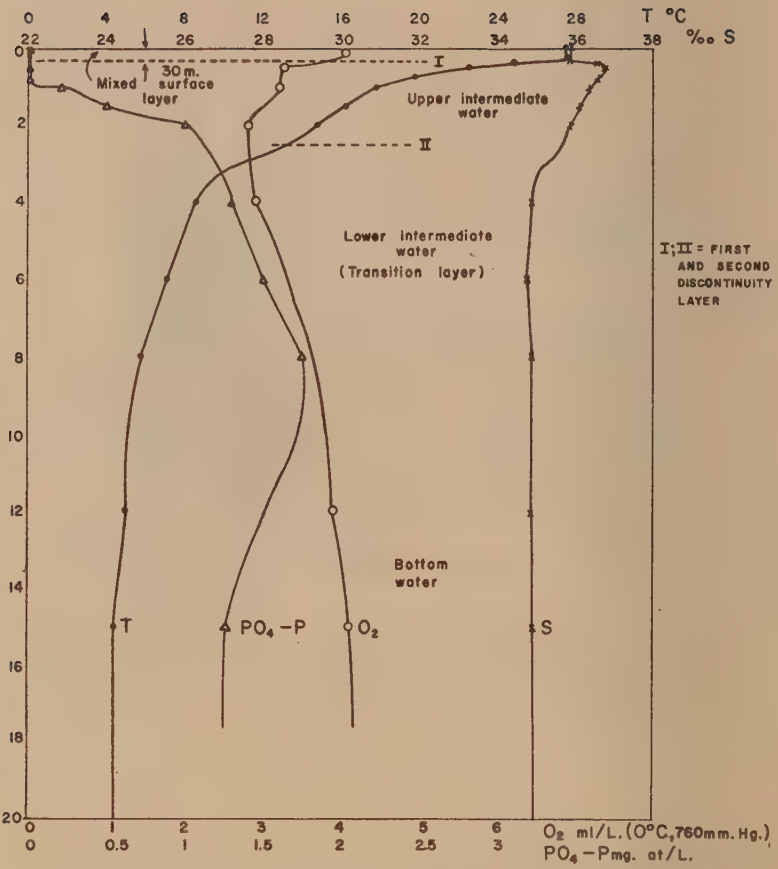


Fig. 10 Depth distribution of temperature, salinity, dissolved oxygen and phosphates in Caribbean Sea, off Gulf of Darien. Data from:
1) Dana St. No 3547 24. VIII 1928 Lat. 11° 00' N. Long. 77° 40' W.
2) Carnegie St 34 9. X 1928 Lat. 11° 18' N. Long. 78° 34' W.

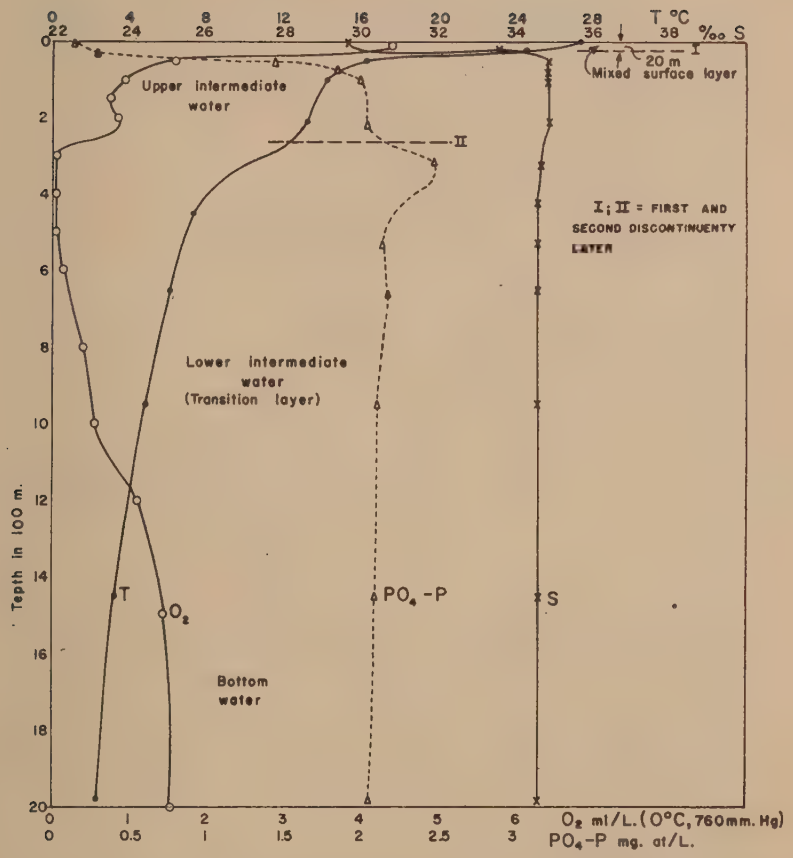


Fig. 11 Depth distribution of temperature, salinity dissolved oxygen and phosphates off the Gulf of Panama. Data from:
1) Carnegie St. No. 35; 26.I.1928 Lat. 6° 32' N. Long. 80° 04' W.
2) Dana St. No. 3548; 3.IX 1928 Lat. 7° 06' N. Long. 79° 55' W.

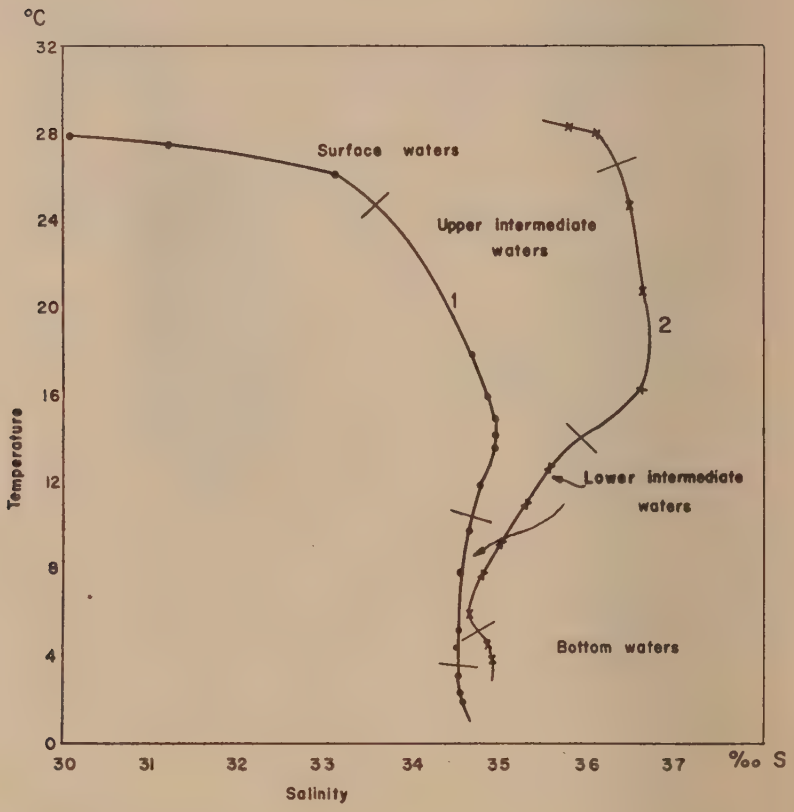


Fig. 12 T. S. diagrams.

1. — Pacific Ocean off Gulf of Panama. Dana St. No. 3548 3. IX 1928
Lat. 7° 06' N. Long. 79° 55' W.

2. — Caribbean Sea off Gulf of Darien. Carnegie St No 34 9. X 1928
Lat. 11° 18' N. Long. 78° 34' W.

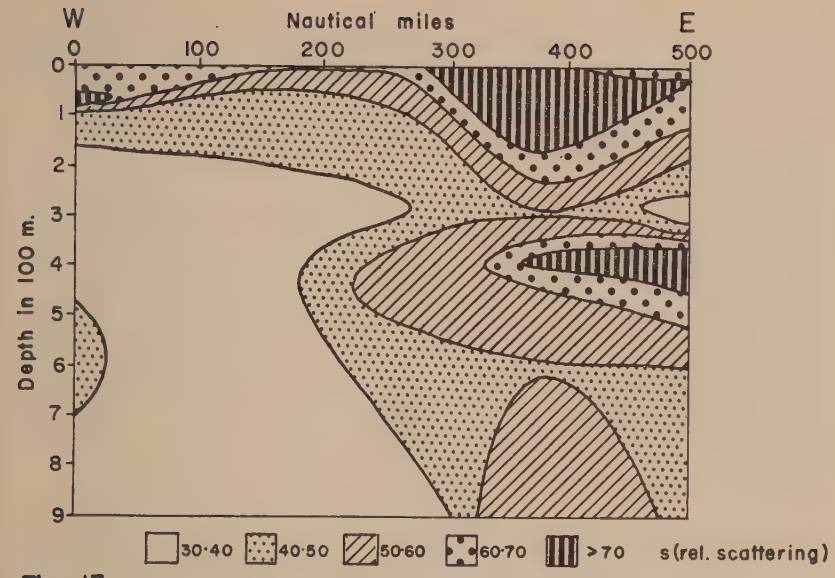


Fig. 13 Particles in a vertical section in Caribbean Sea.
(For location of the section see Fig. 9) After N. G. Jerlov.

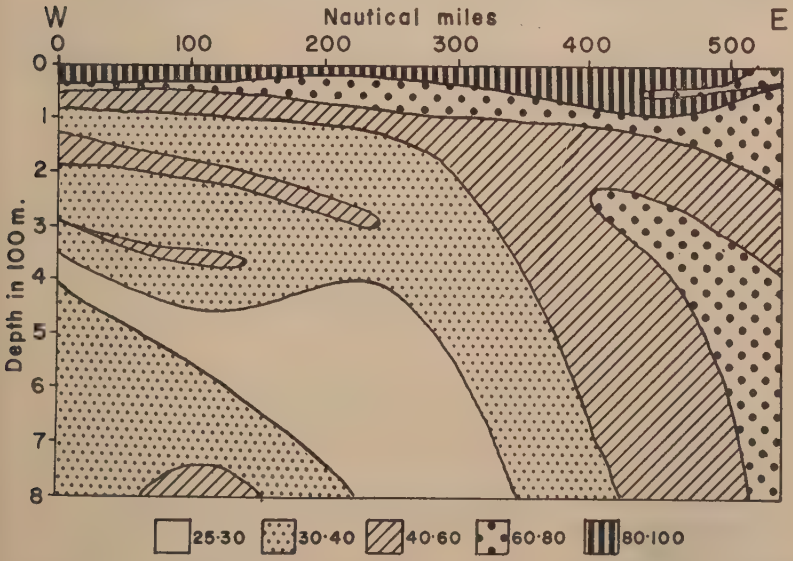


Fig. 14 Particles in a vertical section in the Gulf of Panama
(For location of the section see Fig. 9)
After N. G. Jerlov.

APPENDIX 1

Questionnaire on Oceanographical and Marine Biological Expeditions in the Mediterranean Sea

Country
Name of ship
Name and address of Institution
Area of investigation and number of stations occupied (please include map if possible)
Date and duration of cruise
Oceanographical observations (Mark with X)
Temp., salinity Oxygen
Phosphates, Nitrates
Other oceanographical investigations (specify)
Plankton investigations (specify)
Experimental fishing
Bottom investigations (specify)
List of publications issued or address where unworked materials or unpublished results are available

APPENDIX 2

Synopsis of Data to be Assembled in the Species and Stocks Thesaurus and Methods and Subjects Thesaurus

1. Identity
   - 1.1 Taxonomy
     - Definition
     - Description
   - 1.2 Nomenclature
     - Valid scientific name
     - Synonyms
     - Vernacular names, standard common names
   - 1.3 General variability
     - Subspecific fragmentation (races, varieties, hybrids)
     - Genetic data (chromosome number, protein specificity)
2. Distribution
   - 2.1 Delimitation of the total area of distribution and ecological characterization of this area
   - 2.2 Differential distribution
     - Areas occupied by eggs, larvae and other junior stages: annual variations in these patterns, and seasonal variations for stages persisting over two or more seasons.
     - Areas occupied by adult stages: seasonal and annual variations of these.
   - 2.3 Behavioristic and ecological determinants of the general limits of distribution and of the variations of these limits and of differential distribution.
3. Bionomics and life history
   - 3.1 Reproduction
     - Sexuality (hermaphroditism, heterosexuality, intersexuality)

Maturity (age and size)
Mating (monogamous, poligamous, promiscuous)
Fertilization (internal, external)
Fecundity
Relation of gonad size and egg number to body size and to age
Coefficient of fecundity

Spawning
Spawning seasons (beginning, end, peak)
Number of spawnings per year, frequency
Spawning time of day
Induction of spawning

Spawning grounds
Coastal (surface, vegetation, shore, shoal, sand, shelter); bottom
Oceanic (surface, bottom)

Egg—structure, size, hatching type, parasites and predators

3.2 Larval history
Account of embryonic and juvenile life (prolarva, larva, postlarva, juvenile)
Feeding
Rates of: development and survival
Periods of: development and survival
Parental care
Parasites and predators

3.3 Adult history
Longevity
Hardiness
Competitors
Predators
Parasites and diseases

3.4 Nutrition and growth
Feeding (time, place, manner, season)
Food (type, volume)
Relative and absolute growth patterns and rates
Relation of growth to feeding, to other activities, and to environmental factors

3.5 Behavior
Migration and local movements
Schooling
Reproductive habits

4. Population (Stock)
4.1 Structure
Sex ratio
Age composition
Size composition

4.2 Size and density
Average size
Changes in size

Average density
Changes in density

4.3 Natality and Recruitment
Natality
Natality rates

4.4 Mortality, morbidity
Rates of mortality
Factors or conditions affecting mortality
Factors or conditions affecting morbidity
Relation of morbidity to mortality rates

4.5 Dynamics of population

4.6 Relation of population to community and ecosystem, biological production, etc.

5. Exploitation

5.1 Fishing equipment
Fishing gear
Fishing boats

5.2 Fishing areas
General geographic distribution
Geographical ranges (latitudes, distances from coast, etc.)
Depth ranges

5.3 Fishing seasons
General pattern of fishing season
Duration of fishing season
Dates of beginning, peak and end of season
Variation in time or duration of fishing season
Factors affecting fishing season

5.4 Fishing operations and results
Effort and intensity
Selectivity
Catches

5.5 Fisheries regulations

5.6 Fish farming, transplanting and other intervention.

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Activities of the Corps of Engineers Related to Florida Coastal Fisheries

OSCAR RAWLS

Assist. Chief, Planning and Reports Branch Jacksonville, Florida District, Corps of Engineers, U. S. Army

WE OFTEN HEAR IT SAID that the only way to stay out of trouble is to do nothing. We in the Corps of Engineers find this particularly applicable, since we are the largest construction agency in the Federal Government. Being the principal "doing" agency we have our share of headaches and backaches, and while we do not claim to be perfect we do claim to have a good record.

This paper will be concerned with a rather small segment of the Corps' total responsibilities, namely civil works. To restrict it even more, it will be on civil works in the Jacksonville District that have some effect on coastal waters and estuaries. Only these works could have any direct application to coastal and estuarial fisheries.

The civil works program of the Jacksonville District includes all of Florida east of about Tallahassee, a little of Georgia, Puerto Rico, and the Virgin Islands. Among other things, the Corps is responsible for planning, design, construction, and usually operation and maintenance of federal works for navigation improvement, flood control, and beach erosion control. At present the Jacksonville District has 54 river and harbor projects, one flood control project and 2 beach erosion projects, in total 57 projects. It also has been assigned, or has recently completed, reports investigating the advisability of federal improvement for 31 river and harbor reports, 25 flood control reports and 4 beach erosion reports, a total of 60. This civil works program costs large sums each year, averaging about $12,300,000 annually in the Jacksonville District alone.

All projects that the Corps works on are at the request of the local people. They persuade their Congressman or Senator that a problem exists or that their economic status could be enhanced by a certain improvement. He gets Congress to authorize an investigation, and the Corps of Engineers makes the investigation. An engineering plan is developed and the costs and benefits are analyzed. For an improvement to be favorably recommended in our report to Congress it must be clearly demonstrated that the average annual benefits attributable to the proposed works over their useful life span is greater than the average annual cost of providing and maintaining those works. It is simply based on good business principles. One source of the justifying benefits of harbor projects, for instance, is to the fishing and shrimping industries. Those benefits consist of prevention of damages due to groundings, shorter travel distances to fishing grounds, ability to use larger boats and carry deeper draft cargoes, and increased total catch. Analysis of such benefits requires the careful weighing of such things as whether the fishing ground would be over-fished if the improvement should be provided, whether additional and larger boats would use the port, what effect a larger catch would have on the market, and many other things.

I have often thought of how blissfully ignorant I was during my college days, while studying to be an engineer, of how important would be such things as the price of beans, how many bushels an acre would produce, how much a pound of shrimp is worth, or what a new propeller costs. These things haunt an en-

gineer, because the yardstick of economic worth is the only true measure of the effectiveness of one plan over another, and the only way to see if what we are considering buying is a peach or a lemon.

I can cite an interesting cycle which is apparently about to complete its turn. Back in 1937 and again in 1947 we wrote reports on St. Augustine Harbor, then the state's prime port for shrimping activity. We planned an inlet from Tolomato River to the ocean, stabilized by jetties, and a widening and deepening of San Sebastian River up to the shrimp docks. That improvement showed sound economics and resulted in a favorable recommendation to Congress. The principal justifying benefits were found to be to the shrimping industry. This report was accepted by Congress and part of the improvement was provided by the Corps. But in a few years, the thriving shrimp port at St. Augustine was almost deserted. The discovery of the Tortugas and Campeche shrimping grounds had lured them away to greener pastures. This meant that the Florida shrimp industry had largely shifted to Gulf ports. Although the Corps had already provided good harbor facilities at Charlotte Harbor, Key West, Tampa, and Fort Myers, these became crowded with shrimp boats and more harbors were needed.

In response to this new need of the shrimping interests, the Corps' program was flexible enough to enable us to fill the gap. All facets of the new problem were studied, with the result that deeper and larger harbor facilities were provided at Marathon, Fort Myers Beach, and Everglades. This was done, not through the comparatively long process of the usual report procedure, but as an emergency measure to enable an industry to take advantage of a bonanza of so-called "pink gold." In addition, authorization was given to investigate permanent harbors to accommodate the Gulf shrimp fleet, in case the boom should become a permanently-producing asset. These studies have progressed and federal projects for harbor improvement seem likely. Still others are being studied.

And now this cycle I mentioned may be near its full turn. I have read that the U. S. Fish and Wildlife Service is having quite optimistic results in its scientific exploration for deep water shrimping grounds off Jacksonville and St. Augustine. It may well be that St. Augustine will once more become the queen of Florida shrimp ports. Meanwhile we have completed enlarging San Sebastian River and expect funds to continue the project next year.

Since much of our work is in the coastal area and much of your interest is there too, there are many times when what we do helps you. There are other times when some works could have ill effects on fishing unless careful consideration is given, the facts are known, and there is an intelligent meeting of the minds. We in the Corps of Engineers realize that many species of salt water fish spawn, and feed in coastal waters and estuaries. We also realize that indiscriminately placing of dredged spoil material over feeding grounds can hurt the industry, just as great influxes of muddy fresh water can be very discouraging to salt water species. For that reason we seek good advice from fisheries experts and in the past have shown our willingness to pay for it and the necessary research that goes with it. In the past few years the University of Miami Marine Laboratory has done a study for us. The Corps is also the principal contributor to the support of an area office of the U. S. Fish and Wildlife Service in Vero Beach in connection with the Central and Southern Florida Food Control Project. On our own regular staff we have Mr. Gordon Hall, District Biologist. We also have Dr. Gordon Gunter of Mississippi as Biological Consultant. Our office works closely with the State Board of Conservation, the State Game and

Fresh Water Fish Commission, and many organized groups and individuals who are champions of conservation practices. In short, we try very hard to have our cake and eat it too. We seek very diligently to provide the essential improvements for national progress and at the same time to protect our land, water, and fisheries resources.

As an example, over the past several years, we have found some discontent with the results of the regulation practices at Lake Okeechobee. That large lake is subject to high stages during floods and hurricane wind-tide such as occurred in 1926 and 1928. At that time the sparsely settled lake shores were the scene of mass drownings of over 2500 persons. With today's development in the rich muck soil south of the lake, our responsibility in protecting life and property is even more demanding. There are two main outlets for this lake, St. Lucie Canal to the ocean and Caloosahatchee River to the Gulf. When the floods come water must now be released. The estuary of St. Lucie River near Stuart receives muddy water which drives out the fish, and at least for a while spoils the feeding areas. We have recognized this and have earnestly looked for the facts. We will continue our research there with further field studies in the near future. The U. S. Fish and Wildlife Service is also studying the north fork of the same estuary with Corps funds. Our office has modified its regulation plan to cut the harmful effects to the minimum. Meanwhile, in planning for the Central and Southern Flood Control Project we are now finding what has good promise of being a permanent solution to that problem.

On the other outlet, Caloosahatchee River, there are other problems. The excellent scientific work of The Marine Laboratory of the University of Miami and the Fish and Wildlife Service has reached preliminary findings which seem to indicate that fresh water discharge during rainy seasons may be related to Red Tide in the Gulf. It also appears possible that the Red Tide organism cannot bloom in the absence of water-borne nutrients common to organic muck soils. These same scientists are also progressing beyond the causing stage and into the remedy field. There is reason to hope that the remedy may be simple. At any rate, our office has a keen interest in this research. Plans for future discharge from Lake Okeechobee will be most heavily influenced by those findings, and the flood control planning will be tailored to meet that problem. We already have several alternative plans for providing safe levels in Lake Okeechobee which could well be largely hinged on the final answers of the biologists and other fisheries scientists.

Last year for the first time since 1935 when the Corps began operating St. Lucie Lock on the St. Lucie Canal, we were faced with an unprecedented mullet migration from Lake Okeechobee to coastal waters. We saw many dead fish and others gasping for air as they sought to get to salt water by the millions. Mr. Hall and I arrived there quite by chance at that time. We went into action with further help from the State and Federal fisheries agencies. We began operating the boat locks around-the clock, locking mullet through just as we would lock boats through. This continued throughout the mullet run and resulted in the establishment of a standard operating procedure so that our lock master now can automatically swing into action if and when this ever occurs again. While some fish were killed, since we had no reason to expect this mass migration, we safely passed millions more and saved their lives.

I have spoken at some length of the desires of the Corps to protect fisheries and to provide for other aspects of conservation in its program of planning and construction. There is also a legal requirement for cooperation with fish and

wildlife interests as contained in Public Law 732, 79th Congress, 2nd session, which modifies an earlier act of March 10, 1934. Public Law 732 provides specifically that: whenever the waters of any stream or other body of water are authorized to be impounded, diverted, or otherwise controlled for any purpose whatever by any public or private agency under federal permit that such department or agency first shall consult with the Fish and Wildlife Service and the state agency exercising similar functions, with a view to preventing loss or damage to fish and wildlife resources. The reports and recommendations of those conservation agencies shall be made an integral part of the report of the planning and constructing agency. It further provides that any means and measures required for protection of wildlife resources shall become an integral part of project costs.

We are pleased to comply with those requirements and have demonstrated that willingness by subscribing Corps of Engineers' funds over the past few years which has largely made possible the establishment and maintenance of an area office of the Fish and Wildlife Service in Vero Beach. That office works largely on the fish and wildlife aspects of the $280 million Central and Southern Florida Flood Control Project. The Fish and Wildlife Service receives its own funds for review of the Corps' survey reports planning program, but the Corps has to provide the funds for the detailed biological studies often indicated when the work is advanced to the project stage. The Corps is necessarily limited as to how far it can go in making available for biological investigations funds given to it by Congress for construction. It must necessarily be guided by the restriction of Public Law 732. Sometimes we cannot go as far on research as might be desirable. The solution would seem to be for the Fish and Wildlife Service to be given sufficient funds of their own to do these detailed studies on project planning.

I can cite several other instances where the Jacksonville District has worked closely with federal and state fish and wildlife agencies. A good case in point, however, is the upper St. Johns River portion of the Central and Southern Florida Flood Project. Our original planning on that large project was done in two months and in the face of considerable pressure demanding extreme haste. There had been $60 million in direct flood damages in the area resulting from the 1947 hurricanes and Congress insisted on at least a skeleton plan of flood control. The original plan for the upper St. Johns was little more than engineering judgement, with ample reservation having been made, for detailed planning prior to construction. The plan included three canals from upper St. Johns River to Indian River to divert flood water the short distance to the coastal estuary rather than the 200 or more miles to the mouth of the St. Johns. Local interests along Indian River, including commercial and sports fishermen, felt that such diversion would hurt the fishing. The fish and wildlife agencies also thought so. We had several alternative plans in mind and promised a full detailed study with all factors being properly considered. Meanwhile, we sought the aid of the U. S. Fish and Wildlife Service, the State Board of Conservation, and the State Game and Fresh Water Fish Commission to develop scientific studies to see what results the diversions would have. We also wanted to know how the alternative plans would affect both Indian River and St. Johns River fisheries resources. Meanwhile, we continued our engineering studies. We are now about to complete those studies and find that diversion of flood flows to Indian River is not a good engineering solution. The upper St. Johns flood problems can be best solved by providing flood storage impoundment areas in the

marshes of its upper reaches. This will provide more effective and less expensive flood control than diversion. While the biological studies did not swing the solution in this instance they are in no sense a wasted effort. We will have the results of those studies to influence planning on other future projects. Also, if diversion had not been eliminated for engineering reasons, the biological reasons would have been given their proper major consideration and would likely have had sufficient weight to cause a change of plan. I would like to emphasize that the Corps is not forced into those decisions because of opinions or pressure. Rather, we very strongly desire to make the decisions on the basis of economic merit, engineering soundness, and the results of expert research of all of the other factors that enter in to the project justification. When the scientific evidence and cold facts are present, we have every desire to go along with them. We are also quite willing to change our tentative plans when we can find a better way. It is fundamentally the engineer's job to find a better way to do something for less money.

I hope that my remarks have shown some measure of the very real desire and interest that the Corps of Engineers has, not only in preserving fisheries values, but in enhancing them. The Corps is also interested in continuing to improve the harbors and channels necessary for enabling the salt water fishing industry to operate around the Florida coastline.

The Activities of the U. S. Fish and Wildlife Service, Office of River Basin Studies, in Relation to Federal Water-use Projects and the Marine Fishery Resources of Florida

ARTHUR R. MARSHALL

Office of River Basin Studies,
Fish and Wildlife Service, Vero Beach, Florida.

MR. RAWLS OF THE CORPS OF ENGINEERS in his excellent presentation has relieved me of much descriptive detail regarding the plans for water-use development in Florida.

In this paper, it is intended to stress the problems of conservation connected with projects of the Corps of Engineers in Florida. The effects of Federal projects on marine resources are, however, certainly not confined to any one State.

Since many persons are not familiar with the aims of the Office of River Basin Studies, it is appropriate to describe these briefly. Since World War II the rate of development of the nation's water resources has been accelerated, largely owing to increased Federal participation. Federal agencies participate in water-resource management programs for the purposes of irrigation, flood control, navigation, and power. Many state, municipal, and private organizations also take an active role in such development. Conservationists have long recognized the impact of water-use programs on the fish and wildlife resources. The need has been apparent for incorporation into these construction programs of measures for conservation of fish and wildlife.

In response to this concern, there was enacted, on August 14, 1946, the

"Coordination Act," Public Law 732, 79th Congress. This law authorizes the Fish and Wildlife Service to provide assistance to, and cooperate with, Federal, State, and public or private agencies in planning for fish and wildlife conservation. It also decrees that, whenever the waters of any stream or body of water are authorized to be impounded, diverted, or otherwise controlled for any purpose whatever, by any agency of the United States or by any public or private agency under Federal permit, such agency shall first consult with the Fish and Wildlife Service and the State conservation department concerned, with a view to preventing losses to fish and wildlife resources.

In order to meet more fully the obligations imposed by Congress and to keep abreast of the increasing number of projects, the Service established the Office of River Basin Studies in April, 1945. The major objective of this organization is the determination of the effects of Federal water-use projects on fish and wildlife resources and the formulation of recommendations for the preservation, rehabilitation, and development of fish and wildlife resources affected by these projects.

A number of State conservation departments have attempted to keep abreast of public and private water developments by establishing river basins sections within their own organizations.

Since the establishment of the River Basin Studies organization in the Service, some 2100 investigations and reports on water-use projects have been prepared. At scores of projects throughout the United States, conservation measures have been incorporated in project design and operation as a result of the recommendations in these reports. Conservation, through these activities, is a living reality at these projects, where otherwise severe destruction of fish and wildlife resources would have resulted.

A River Basins field office was established at Vero Beach, Florida, in February, 1955. Its principal mission has been the study of the far-flung Central and Southern Florida Flood Control Project. This project, most of which has been authorized by the Congress, is likely to have a profound effect on fish and wildlife resources of nearly all of the eastern half of Florida. It may cause major changes in the habitat for commercial and sports fishery resources in the fresh and saline waters in and adjacent to the Florida mainland. It is the conservation and protection of these resources to which the efforts of the Vero Beach office have been addressed. The methods by which this investigation is being conducted will be of interest.

At this point the cooperative nature of the River Basin investigations in Florida with the State agencies, should be emphasized. The program has been developed in conjunction with the Florida State Board of Conservation and the Florida Game and Fresh Water Fish Commission, both of which are actively engaged in investigations of this project. These agencies, particularly the Board of Conservation, together with the universities in the State, are carrying the major load in biological research, which is a necessary basis for the investigations. We have developed joint procedures with the two State agencies so that the work of each of the three agencies complements the other two, and so that the information developed by each cooperator can be fitted into the need for data by the others. Duplication of effort is thus avoided.

Fundamental to the investigations by all three agencies are the biological analyses of the effect of dams, dikes, and canals on the habitat of the fish

and wildlife species involved. Trained biologists make estimates of the changes in salinity, for example, and the probable effect of such changes on the welfare and abundance of various fish and wildlife species.

The first step in this type of analysis is the evaluation and appraisal of biological conditions as they exist prior to the construction of one of these water control structures. Following this, an estimate is made of the biological conditions as they might exist after construction of the project. On the basis of differences between these two analyses, conservation measures are developed for recommendation as part of the project plans.

In rare cases a recommendation is made that a project, or a unit of a project, not be constructed at all. The basis for such a recommendation is that the benefits to be derived from leaving the fish and wildlife habitat as nature made it exceed those which are likely to be derived from the construction. More commonly the recommendations are for modifications in the design or operation plan of the water-control project for the benefit of fish and wildlife conservation. These modifications may include, for example, sustained minimum flows below dams to maintain fish life, the construction of sub-impoundment areas on reservoirs to provide controlled water levels for the benefit of waterfowl and other water-related species of wildlife, and the construction of fish-attracting devices for placement in reservoirs.

The economic effects of a proposed water-development project on fish and wildlife are determined largely by comparing human utilization of these species expected to occur with and without the project.

The anticipated economic effects of a project on harvested fish and wildlife resources are expressed, to a large extent, in monetary terms. In the case of commercial fish and fur animals, annual harvests are evaluated in terms of market prices at the point where the products are first sold in the market. Expected annual sportfish and game harvests, or day-use by sportsmen, are evaluated on the basis of money spent by sportsmen in connection with their fishing and hunting trips. Unharvested species are not evaluated in monetary terms, but their importance is presented in River Basin reports by appropriate description.

By evaluating the commercial and game species in a project area without and with the project, it is possible to show monetary gains or losses to fish and wildlife resources. These dollar values give some indication of the relation of fish and wildlife resources to the agricultural and other resources which are considered in the economic analysis of a project by the construction agency. The monetary gains or losses to fish and wildlife may be included by the construction agency in the project benefit-cost ratio which is used to determine economic justification for project construction.

As I have noted, the Central and Southern Florida Flood Control Project is the principal water control project in Florida with which the Service is concerned. The purpose of this project is to provide some measure of control over the extremes of flood and drought which Florida historically has experienced in the St. Johns and Kissimmee River valleys, in the Everglades, and on the lower east coast.

In addition to large interior water-storage reservoirs, this project will include several canals which will be used as routes for discharge of excess water to the sea. One of these, the St. Lucie Canal, which discharges into the St. Lucie River at Stuart, is presently in operation at project capacity. Canals such as this cause considerable changes in the physical and chemical aspects of

the receiving estuaries, and, therefore, create a part of the problem of conservation of the estuarine resources. Another major Federal water-use project in Florida with which we are concerned, is the Intracoastal Waterway, a portion of which traverses the bays and lagoons of the east coast from Jacksonville to Miami.

One of the major difficulties in the investigations of Florida's estuarine resources is the lack of requisite biological knowledge of estuaries. This problem is a knotty one and considerable research will be required for its solution. We first need to know more of the mechanics of estuarine productivity. For example, we want to find out what organisms utilize estuaries for breeding, nursery grounds, and feeding, and to learn the character of their nutritional relationships. We need also a more complete understanding of the reliance of the non-estuarine coastal fauna on the estuaries.

In addition to these basic matters, there are certain specific questions which appear repeatedly in our investigations. One is the matter of salinity tolerances, and here we need to know not only minimum tolerances, but also tolerances to differing rates, duration, and frequency of change. Another frequent problem is that of the materials which are brought in suspension into the estuaries by fresh water discharges. While we recognize that repeated blanketing of a bottom can cause damages to the biota, we think it important to know whether plant detritus, which may settle out into thick blankets, does or does not contribute eventually to production of a richer fauna as the result of nutrient enrichment.

Other recurring questions are: What effects does channelization of a lagoon have on its biota? If there are harmful effects, can they be lessened by selection of some particular route through the lagoon? Further, what is the least harmful method of disposing of spoil resulting from dredging?

With the answers to these questions provided by research, managerial and planning efforts will be far more effective.

This problem which we have encountered is a part of the total problem confronting those concerned with maintenance of Florida's estuarine resources. No observer can fail to be impressed with the great use to which these resources are put. Sport and commercial fishing, recreational boating and bathing, in the coastal bays and lagoons, are all very extensive. On the other hand, an observer must also be impressed with the considerable losses that these same resources seem to be undergoing as a result of Florida's phenomenal growth.

Dr. F. G. Walton Smith, Director of the University of Miami Marine Laboratory, puts it this way:

> "In the first place I consider that the effects of clearing and filling mangrove swamps, building sea walls, and otherwise changing the natural drainage patterns have a very considerable effect upon the natural conditions of the estuaries and inland waterways of the state. Probably this is more important in its effects than human sewage pollution, except to the extent that the latter renders shellfish unfit for consumption. Industrial pollution may be far more harmful, depending upon its nature. All of these factors, however, are probably more effective in altering ecological patterns and interfering with the natural production of fish than the effects of commercial fishing or angling themselves.
>
> "These factors have been particularly serious in the more heavily

populated areas of Florida and promise to become even more serious in the future, with the ever-increasing scope of real estate development throughout the state.

"Since estuarine waters, including the inland waterways form a considerable part of the angling and recreational area of the state, the above matters should, in my opinion, be ranked high in order of priority for investigation."

Mr. Ernest Mitts, Director of the Florida State Board of Conservation, shares Dr. Smith's views. Mr. Mitts says:

"First, we feel that many of the habitats of Florida's coastal areas have declined from the standpoint of marine and estuarine animal populations. Our feeling is that much of the decline has been due to the fact that the habitat and its role in fish and invertebrate abundance has been overlooked.

"Second, we feel that the gradual abuse and elimination of the natural habitat constitutes one of the most acute of the many problems facing us at this time."

Dredging and filling operations have been conducted in many estuarine areas for various developmental purposes. Two prime examples of this have occurred in Biscayne Bay in Miami, and in the north end of Boca Ciega Bay at St. Petersburg. In each case, substantial acreages of estuarine bottom has become dry land. If for no reason other than reduction of water acreage, this procedure is obviously harmful to fish and their habitat.

Of course, the growth of population and industry brings increased possibilities for the introduction of pollutant materials into estuarine waters, as has occurred in other states. While many agencies (federal, state, local, and industrial) are working on this aspect, much remains to be done, if the receiving estuaries are not to be overtaxed.

Projects for flood control, drainage, and navigation have also contributed in certain instances to the deterioration of the estuarine environment. Certainly the discharges of the St. Lucie Canal into the river at Stuart have had some adverse effect, even though unmeasured, on the biota of that body of water. Alterations of salinity and sedimentation which accompany such projects can have serious effects.

There are available few actual measures of the present fishery values of estuarine waters. These values are needed before appropriate decisions can be made in project planning. Several current surveys of the Florida State Board of Conservation, in addition to our studies, are designed to determine these values, in terms of human utilization and business generated.

We do know, from a qualitative point of view, that the estuarine resources contribute in large measure to Florida's economy. Many individuals and concerns derive some or all of their income from the extensive utilization of these resources. Undoubtedly Florida's estuaries play a significant role in attracting visitors to the state, and in contributing to its phenomenal growth.

In considering opportunities for conservation of Florida's estuarine resources, a first advantage we have is that the problem of estuarine deterioration is generally recognized by professional and lay people alike, and public interest is high. Such interest is essential. It is obviously far more effective to recognize and combat potential damaging influences as they confront you than it is to attempt to rectify their harm after it is done.

A second factor that can contribute to success is that there are in Florida

a number of organizations and facilities which are capable of coping with some part or all of the problem, and which have common interests. These include the State Board of Conservation, the Game and Fresh Water Fish Commission, the public health agencies, the Corps of Engineers, and certain municipal and industrial elements, in addition to the Fish and Wildlife Service. Certainly the state agencies are active and progressive groups, with clearly demonstrated abilities and interest, as we know from our associations with them in cooperative studies of water-use development projects.

In the way of research facilities, there are the Oceanographic Institute at Florida State University, the St. Petersburg Laboratory of the Board of Conservation, The Marine Laboratory at the University of Miami, and graduate student research programs in the biology departments of the colleges and universities.

It should be emphasized that the Corps of Engineers, which is constructing the Central and Southern Florida Flood Control Project and other projects, is cooperative in the field of fish and wildlife conservation. The Corps not only has its own staff biologist, Mr. Gordon Hall, at the Jacksonville office, but also has enlisted the assistance of marine scientist Gordon Gunter.

Florida's estuarine resources appear to be at a cross-roads, and an unfavorable balance can come in the near future if persons interested in these resources do not continue actively to represent their case. Opportunity still remains to retain these resources, and to regain some of those portions which have been lost. It is not possible to predict what the total effect of the water-use programs on the estuaries will be. We can be sure, however, that the total effect will be unfavorable unless these resources are given every reasonable consideration in project planning. We realize that much needs to be done to further the effectiveness of our activities and the activities of those concerned with the total problem of estuarine conservation.

We are vitally interested, along with you, in the preservation of these resources, which are so outstanding a characteristic of the unique Florida scene. We are disturbed at the deterioration which seems to have occurred, and we shall work with you and for you toward lessening their attrition, within the area of our authority.

DISCUSSION

Caribbean and General Session

Discussion Leader: L. S. Mowbray

Discussion Panel: Oris Russell, Frank J. Mather III, Hector Ferreira

The Present Situation in the Fishing Industry of Cuba

Jose A. Suarez Caabro

Q. Mowbray: How are the tuna and grouper caught in Cuba?

A. Suarez: In Cuba we catch tuna using the Japanese method of pole

and line from small boats. We catch grouper in deep water at Campeche using handlines. We tried electric reels, but fishermen prefer the handline.

Q. Mowbray: Is the region of Guatanamo Bay a productive area for spiny lobster fishing?

A. Suarez: The main spiny lobster grounds are south of Havana. I do not think they catch many spiny lobsters commercially in the area you mentioned.

Q. Russell: What method did you use to obtain your estimates on landings of fish?

A. Suarez: From the canneries and the commercial fishing establishments. Because of taxes and other factors it is difficult to get accurate figures.

Q. Ferreira: What type of tuna do you can?

A. Suarez: Skipjack or ocean bonito (*Katsuwonus pelamis*), and blackfin tuna, (*Thunnus atlanticus*).

Q. Ferreira: Do you consume all your canned tuna at home?

A. Suarez: Yes, we produce about half of our consumption. The other half comes from Spain or the United States.

Q. Ferreira: Do you can other fishes besides tuna?

A. Suarez: No. A few years ago we tried canning sardines but it was not successful.

Q. Rosa: What is the status of your marine laboratory?

A. Suarez: It is closed.

The Marine Fisheries of Yucatan, Mexico

Jorge Carranza

Q. Russell: Do you utilize any of the products from your sharks or do you ship them all to the United States?

A. Ferreira: The dried, salted meat provides a very low priced protein product and this is consumed in Mexico. We used to import a great deal of cod but now the shark meat is utilized to a greater extent. Fresh livers for vitamin A are shipped to the U. S. and so are the hides and fins, used by the Chinese population for their famed sharkfin soup.

Q. Strasburger: How many shrimp boats do you have on the west coast of Mexico?

A. Ferreira: The total number of trawlers operating as far south as Salina Cruz probably comes to 500. They are mostly old boats. Close to 100 new boats are being built along the Pacific Coast to replace these older boats.

Q. Murdock: What is the comparative cost of constructing a 67 foot shrimp boat in your yards to those of the United States?

A. Ferreira: Our construction costs are lower than yours by about 25 per cent. New boats, 65 feet long with a Caterpillar engine model D342 are costing from $33,000 to $36,000 on the Pacific coast. I understand your costs are approximately $45,000 for that size boat.

Q. Wilkensen: Is any canning of pilchards done in Mexico?

A. Ferreira: Mexico cans sufficient pilchards for its own domestic market only. The fishing is done on the Pacific Coast only, close to the California border. The canneries are established at Ensenada, B. C., about 60 miles from the border.

Ways and Means of Promoting Improvements in a Caribbean Fishery

DUDLEY W. WILES

Q. Mowbray: What happened after the disastrous hurricane that disabled the fishing fleet in the Barbados last year?

A. Wiles: After hurricane Janet in September, 1955, we had 25 boats completely destroyed, 36 boats knocked to pieces and 19 rowboats lost, to say nothing of fishermen's houses. Their families were completely disorganized and without food or clothing. I suggested that we replace the sailboats with launches. We helped rebuild power type hulls and made the fishermen eligible for a loan from the government. The fishermen could borrow up to $2,160 to help him put a small diesel engine into his boat. We have completed over 25 replacements and repaired all the sailboats that could be fixed. The biggest development throughout the island has been the general mechanizing of the fishing fleet. A few years ago we had only 25 powered boats. When I left Barbados last week we had 197, and 14 more will be registered in another ten days. So we have been moving very quickly to try to get another type of boat which will be safer and do a better job for the fishermen.

Q. Ferreira: How were you able to recruit fishermen to the industry in Barbados to increase your production?

A. Wiles: Actually, we have used the same men and the increasing production was not due to an increased number of fishermen, but to the introduction of the use of gill nets for flying fish. The men have always been available from the sailboats to be used on the boats that are mechanized. Many of the sailboats will not be used any longer.

Q. Mather: In the Virgin Islands we have mostly old fishermen with no young men coming into the fishery. With most of our young men being attracted to other industries such as tourism, I think we might have a recruitment problem in a few years and I want to ask if Mr. Wiles has any comments to make on this situation in the Virgin Islands.

A. Wiles: To recruit new blood into the industry, fishing must be made safer, and a man must be able to make a living wage.

Q. Rosa: Have you any reason for not including the continental countries such as Venezuela, Colombia and Central America in your zoning scheme? Are there research boats to carry on this program and, if there are such boats, would they carry on all the exploratory and experimental fishing?

A. Wiles: The idea of zoning the islands of the West Indies was put forth to get things started and to get people thinking that there are some fish in the area. Most reports of this area give a very pessimistic view of the fisheries and we have not found it really to be so. I thought that my suggestion was quite an ambitious task, but the other areas should be included in a larger plan. I really look forward to seeing FAO work on this plan. I thought that if we had a research boat for each zone that a very good start could be made. I would leave the actual planning of the work for the research boats to the fishery advisory committee in each zone.

Q. Kahn: Where do the subsidies come from that are paid on salt fish? Who receives these subsidies?

A. Wiles: The government in trying to keep the price of fish down, has subsidized the retail price of salt fish and that has been paid direct to the first importer. Then he is able to sell it to the various retailers at a reduced price. The retailer has a controlled figure set by government audit. Even under subsidy, the price of controlled salt fish is now selling for 8-10 cents a pound higher than fresh fish in some of the colonies.

The Survey of Living Aquatic Resources

H. Rosa

Q. Russell: How does the FAO award fellowships and grant technical assistance to participating countries? How do they provide the funds?

A. Rosa: This is administered by the technical assistance board of the United Nations. It is a fund made up by contributions of different countries directed to the United Nations and the technical assistance board divides this fund among the specialized agencies. We establish with this fund a share for each country and, depending upon requests we receive from the countries, we provide experts or technicians. We pay the salaries of the technicians and their traveling expenses and sometimes we provide some equipment. The expenses in the country, like travelling, and per diem, are paid by the country. Regarding fellowships, our main object is to secure continuation of the project. We don't keep a foreign expert in the country for more than two or three years at the most, but we want to make sure that his work will be continued

when he leaves. The country is supposed to supply one competent technician to continue the work. When the expert finds a man really interested in this work he recommends him for a fellowship. We do not normally award fellowships to countries where we have no experts working in the field.

Q. Wiles: Could we look forward to help from FAO in the project I discussed this morning?

A. Rosa: Yes, we have a man working with the Caribbean Commission now. It would be up to him to evaluate this project and recommend what action FAO should take.

Q. Kahn: Do you think FAO would be willing to help train fishery economists by giving scholarships or fellowships to universities for this purpose?

A. Rosa: Yes, if the interested country would request it well in advance we will be glad to consider these fellowships. We recognize that there is a scarcity of fishery economists. Our program is planned a year in advance so that any request now would be considered for 1958.

Activities of the Corps of Engineers as they Affect the Coastal Waters of Florida

OSCAR G. RAWLS

Q. Ferreira: Is the program of the Corps of Engineers financed entirely by the U. S. government?

A. Rawls: The amount of federal contributions in projects varies considerably with the project. In the case of navigational improvements almost the entire cost is borne by the federal government. The local interests, as we call anybody other than the federal government, contribute only the land and rights of way for normal navigation and river and harbor projects. In the case of flood control it's a different matter, and the local contribution is considerable. We divide the categories of benefits into two parts, one being those which are considered to be entirely of federal interest, such as navigation as it may be related to flood control, fish and wildlife activities, and the prevention of flood damage. There is another activity which is predominant in some of these projects, namely increased land use, that is, obtaining greater production by reason of flood protection. Obviously that benefit accrues to the land owner himself, for the most part, although there is a considerable national or federal interest in it. In cases like that the local interests pay for about half.

Q. Russell: Is the migration of mullet out of Lake Okeechobee an annual occurrence?

A. Rawls: Yes, it is usually a small affair and, up until last year, it was the kind of thing that the normal movement of boats

through the locks took care of without any special preparation. But last year, for some unknown reason, these mullet sought to get out by the millions. We couldn't put a fish ladder in that would do anything like the job that can be done by the lock.

Q. Kahn: On the question of evaluating benefits in preparation for engineering projects, there has been the criterion established that the value of the commercial fisheries is established by the value of the annual catch, and the value of the sport fishery is what the sport fishermen spent. I do not think this type of evaluation is correct. What the fisherman has as income is not all profit and besides, when a fishery is destroyed, income is taken away from the processor, wholesaler and the retailer. These factors are never considered. On the other hand, what the sport fishermen spends is not all profit for the area. Would you agree that this evaluation system could be improved?

A. Rawls: Yes, there is great room for improvement in both sports and commercial fisheries analysis of benefits.

The Activities of the Fish and Wildlife Service, Office of River Basin Studies, in Florida

ARTHUR R. MARSHALL

Q. Heydecker: Do you think, on the basis of the studies that you are now making, that it will be possible to appraise the estuarine waters and marshlands to such an extent that you would be able to determine their highest economic use, whether as nursery grounds for the fisheries, or as farm areas?

A. Marshall: Yes, I believe if the proper studies are made we will be able to make reasonably sound estimates of the relative importance of the various possible uses for various stretches of water. Without research, however, this task would be hopeless.

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